Sky and TELESCOPE

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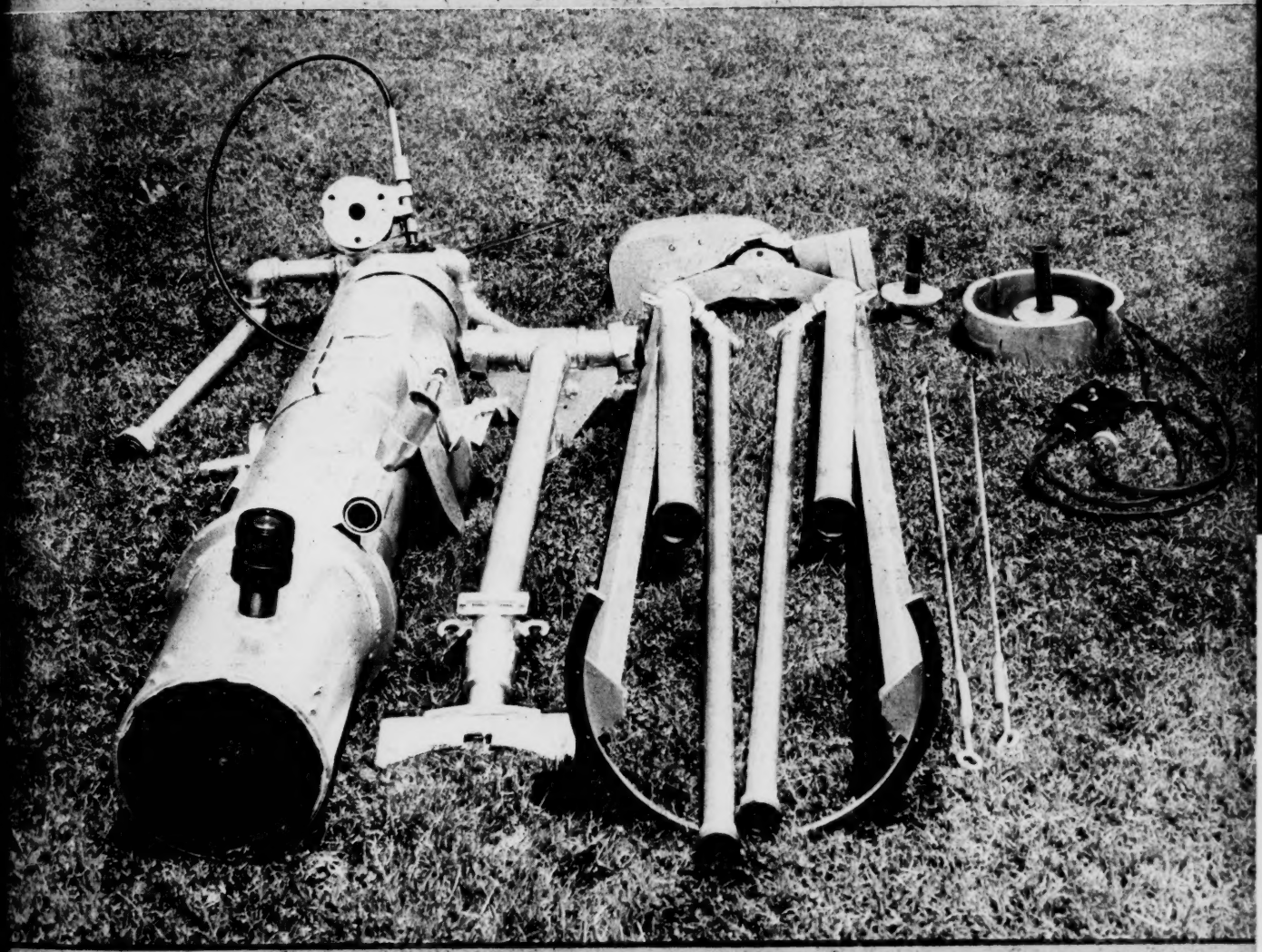

Disassembled portable reflector

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Vol. XI, No. 3
JANUARY, 1952
Whole Number 123
★

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The Observatory Key
Stars for January
Ungava Crater from the Air
Graphic Time Table of the Heavens

A BUDGET FOR ASTRONOMY

THE OCTOBER, 1951, number of the *Astronomical Journal* contains a draft of a proposal for the support of astronomy by the National Science Foundation. It is the report of a special committee to study relations between astronomers and the foundation, and recommends that the committee of seven astronomers which has served in an advisory capacity to the Office of Naval Research be continued as an advisory body on astronomical matters to the foundation.

The committee proposed "essentially a minimal budget" in astronomy for the first year of full operation of the foundation, July 1, 1951, to June 30, 1952.

Fellowships	$ 35,000
Publications	35,000
Short-term research projects	160,000
Capital equipment grants	150,000

Concerning the fellowships, it is stated: "The prime requisite for successful expansion of the field of astronomy is the support of brilliant young men interested in pure science who now must enter fields of industry, engineering, and physics where the ultimate salaries are high and financial security greater. Universities and observatories can now offer mainly teaching fellowships and assistantships of small amounts. It is necessary to provide twelve to fifteen additional graduate fellowships per annum to meet the required support of students working toward the Ph.D. degree. The average rate of graduation of Ph.D. students has been about eight per year and is momentarily higher. Good men, however, are in very great demand, and major positions are open in several observatories for lack of suitable candidates."

As for publications, it is pointed out that the major technical astronomical journals in this country are operated at a loss, and that they have no permanent endowments. Overcrowding of the journals exists, and publication is subject to long delay. Astronomical monographs are difficult to publish at all, and major completed research monographs already exist which will require about $15,000 to publish.

The experience with short-term research projects has been most encouraging; a program of this kind, with a limit of $5,000 per project, is now in its fourth year of operation under the Office of Naval Research. The work of 75 astronomers and assistants is being very effectively aided by the ONR program, but the 1951 allocation of funds was insufficient, and projects aggregating $80,000 could not be undertaken. It is proposed that the limit per project be set near $10,000 for National Science Foundation grants. Research at smaller institutions should be encouraged.

Concerning the needs for additional equipment, the report states: "During the 25 years from 1923 to 1948, which includes the depression and the war, telescopes and auxiliary equipment were built at a total cost of about $2,000,000 (excluding the 200-inch). In view of the increase in cost of precision equipment, it must be estimated that the replacement cost would be near $5,000,000; the annual rate of $200,000 is thus indicated for future years unless the rate of progress in astronomy is to be reduced in the future. Older equipment also will tend towards obsolescence without such expansion. In this figure we have not included the cost of the Palomar Observatory ($6,500,000), or of eclipse expeditions and special equipment; inclusion of these items would bring the past total expenditures for equipment, without allowance for increased construction costs, to about $400,000 per annum over the last 25 years. There are about 40 institutions at which astronomical research is being carried on.

"In the first year of operation it is not proposed that large new facilities be provided. The major and very immediate need is to provide funds for several large grants for the modernization of existing telescopes and the construction of auxiliary equipment used in the analysis of the observations. In several major observatories large telescopes are approaching the point of obsolescence because of the high cost of modern electronic drive and control equipment and precision mountings. The expansion of the cities near which universities were built has in many cases rendered present locations unsuitable for research. Modernization of existing equipment and construction of devices

(Continued on page 57)

Sky and TELESCOPE

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BACK COVER: NGC 6720, the Ring nebula in Lyra, Messier 57, the most famous of the planetary nebulae, for which the central stars are believed to be among the hottest known. Mount Wilson and Palomar Observatories photograph with the 200-inch Hale telescope. (See page 55.)

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Almost all of Orion's bright stars are of spectral type B, hot and blue-white. In this picture, taken with ordinary blue-sensitive emulsion and showing photographic magnitudes, only Betelgeuse, cool and red, appears relatively much fainter than it does to the eye. Photograph by Charles W. Elmer.

THE HOTTEST STAR--I

BY OTTO STRUVE, *Berkeley Astronomical Department*
University of California

NEARLY every astronomer knows that the infrared component of Epsilon Aurigae is the largest, and at the same time, the coolest star on record; that Plaskett's famous spectroscopic binary, HD 47129, has the greatest mass; and that in all probability Strand's faint companion of 61 Cygni is the least massive self-luminous star yet investigated. But ask him which star is the hottest, and you will only embarrass him, for he has no satisfactory answer; and in this lack of knowledge there lies an interesting story.

Superficially, it would seem easy to find the surface temperatures of the stars. Even with the naked eye we distinguish the reddish color of Antares or Betelgeuse from the bluish light of Sirius or Rigel. If we could measure the colors of the stars, and calibrate them in terms of temperatures, our problem would appear to be solved. Long ago this method was first employed by Vogel and his collaborators at Potsdam, and in 1905-09 one of astronomy's great classics, a Potsdam publication by Wilsing and Scheiner, took shape in the form of a list of representative stellar temperatures.

In this, and in many subsequent investigations, the stars were assumed to behave as *black bodies*. This assumption was necessary, but it is not easily understandable. Why, indeed, should the brilliant light of a star resemble the "blackness" of everyday experience? The difficulty is more-or-less removed when we realize that what we discern as "black" in the glare of the day is the property of a substance to absorb all radiation falling upon it, and to re-emit it as heat. We can easily convince ourselves of the re-emission if we touch a black piece of metal exposed to full sunlight!

The physicists have given a definition of "blackness," involving the absorption of all radiation, and they have combined it with a famous law by Kirchhoff which states that there is a relation between the absorbing power of any body and its emission of radiation: At a given temperature the emission divided by the absorption is the same for all bodies and is equal to the emissive power of a complete absorber, or black body, at the same temperature.

The emission of a black body is accurately known from the work of Max Planck. It can be demonstrated as a somewhat complicated formula, or it can be shown in a diagram, which contains a family of curves labeled with the corresponding temperatures (Fig. 1). The abscissae are wave lengths and the ordinates are intensities of light or heat. The total amount of radiation is small for low temperatures and large for high temperatures; it varies as the fourth power of the absolute temperature, T.

The maxima of the curves are not all in the same place of the wave length scale. They may be computed from the fact that the wave length of maximum intensity is equal to $3 \times 10^7/T$ angstroms. For example, at room temperature, about 300° absolute, the maximum is at wave length 10^5 angstroms or 0.01 millimeter. This is "invisible light" and belongs to the domain of microwaves. But if the temperature is 3,000°, the maximum intensity is at 1μ (one micron), which is detectable with infrared photographic plates; and if $T = 30{,}000°$, then the maximum is at 1000 angstroms, in the invisible ultraviolet. For the sun, the observed maximum of the light intensity in the normal spectrum (corrected to outside the earth's atmosphere) is in the yellow — at about 6000 angstroms. Correspondingly, the formula gives the solar temperature as 5,000° absolute.

Because the actual maxima of the Planck curves fall outside the observable range of the spectrum, except for a narrow range of temperatures, from 3,000° to 10,000°, we rarely use this method to determine actual stellar temperatures. Most work has been based upon finding the ratios of the intensities at two specified wave lengths, say 4300 and 5400 angstroms, and then finding, by trial and

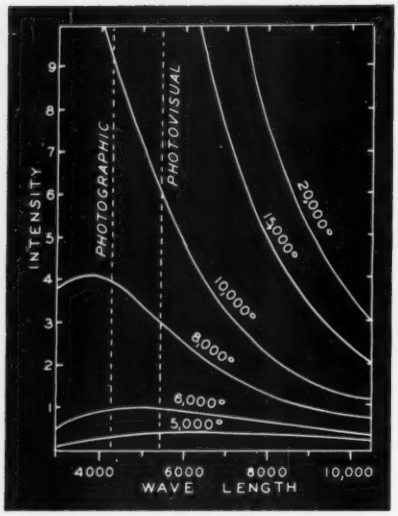


Fig. 1. Curves of relative energies radiated by a "black body," adapted from Aller. The dashed vertical lines mark the regions for which photographic and photovisual magnitudes are effectively measured.

error, which of the curves in Fig. 1 satisfies the observations.

As an intermediate result, the brightness of a star is observed separately through yellow and violet screens (Fig. 2). The difference in the magnitudes thus obtained is designated as the *color index* of the star. We arbitrarily set the color index of an *A*-type star (like Vega) as zero. Then the sun has a color index of about +0.7 magnitude, and a really blue star, like Rigel, has one of about −0.2 magnitude.

The whole procedure is essentially the same as trying to find the appropriate curve in Fig. 1. It turns out, from the Planck formula which describes these curves, that there is a simple expression:

$$T = \frac{7{,}200}{\text{Color index} + 0.64}$$

Thus, Vega has a color index of zero, and $T = 7{,}200/(0 + 0.64) = 11{,}200°$. A red star like Antares has a color index of 1.7, and $T = 7{,}200/(1.7 + 0.64) = 3{,}000°$.

When the color index is −0.64, the denominator in the expression is zero, and the corresponding temperature is infinite. There can be no color index bluer than −0.64, or the temperature would become negative, which is physically absurd. Until recently, this restriction upon the color indices conformed to the experience of the observers. The bluest stars, Tau Canis Majoris and Zeta Puppis, had observed color indices of −0.3 magnitude.

A recent issue of the *Astrophysical Journal* contains two short papers from the Warner and Swasey Observatory of the Case Institute of Technology — one by D. A. MacRae, R. Fleischer, and E. B. Weston; the other by D. L. Harris. They call attention to a faint star, BD +28°4211, which has a color index of the order of −0.62 magnitude. This would correspond to a color temperature of 350,000°! Together with a few other faint stars previously found by Humason and Zwicky, and by Schilt and Jackson, it is one of the bluest stars yet measured.

Not many years ago it would not have been considered out of place to ask whether such large temperatures have any reality whatsoever. I remember a distinguished astronomer once remarking that to him 100,000° or 1,000,000° represented so large an extrapolation of known facts that he refused to believe in them. By contrast, it is interesting to recall Eddington's quiet reassurance in his 1927 book, *Stars and Atoms,* that even the 40,000,000° then believed to occur in the interior of a star had a definite physical meaning, and a simple one at that. It represents the state of chaotic motions of the atoms and electrons in the gas. The atomic bomb, with its millions of degrees in temperature, has now relegated contrary arguments into the domain of history.

But the Case Institute authors have no confidence that the phenomenally high temperature is physically real. We had assumed that the stars were black bodies; but our only real evidence in support of this assumption was the superficial resemblance of the sun's energy distribution with one of the curves of Fig. 1 — and even that is correct only between narrow limits of wave length.

It was always difficult to justify the assumption; the early workers used it because they had nothing better, and they realized its limitations. Then there came a period during which astronomers were trying to forget about the limitations, always hoping that in the end the black-body assumption would prove to be correct. But these hopes were not well founded. Instead of resembling a Planck curve, the energy distribution of a star may look entirely different, as shown by Fig. 3. It is, in fact, difficult to understand why so much confidence was placed upon the black-body assumption. Even if the inside of a star resembles the perfect cavity (*Hohlraum*) of the physicists, in which the mysterious conditions of "thermodynamic equilibrium" prevail, the black-body radiation of very high temperature (20 million degrees at the sun's center) must work its way through the cooler outer strata, and it is in them that it loses its black-body character.

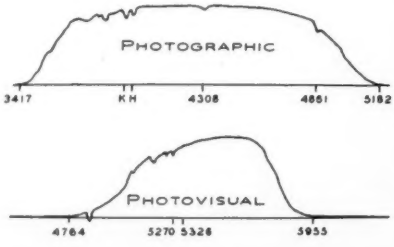


Fig. 2. The spectral regions comprised in photographic and photovisual magnitudes, by Seares and Joyner. These represent microphotometer tracings of small-scale transmission-grating spectrograms of northern sky light on Mount Wilson. The average weighted mean wave lengths of these density curves were found to be 4270 and 5430 angstroms, respectively.

The spectrum of the Case Institute star is remarkable, principally because it shows hardly any lines. At Michigan, several faint lines were measured, and at Yerkes, W. W. Morgan, the world's leading authority on the classification of stellar spectra, wrote: ". . . It resembles no other star in the Yerkes files. . . . The spectrum contains faint, rather broad, lines of hydrogen and a strong line near λ4686 which appears to be due to ionized helium. No other lines are seen with certainty on low-dispersion plates. . . ."

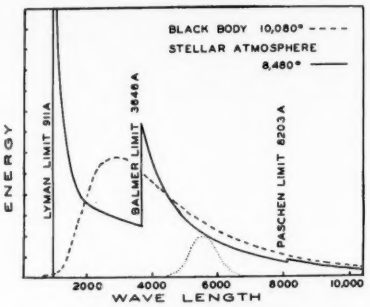


Fig. 3. The behavior of hydrogen in a star's atmosphere causes its energy emission to show serious discrepancies with the theoretical curve of a perfect radiator. In this diagram by Pannekoek, the visible region of the spectrum is shown by the small, dotted curve.

Morgan also finds that BD +28°4211 is a subluminous *O*-type star, an object that is excessively blue, not necessarily because its temperature is excessively high, but because it has an anomalous spectrum!

A high-dispersion spectrogram of this interesting star has recently been obtained with the Mount Wilson coude spectrograph, by J. L. Greenstein, and to him I am indebted for a "peek" at his plate. The absorption lines are indeed weak, as though they were blurred out by some overlying continuous spectrum. One is reminded of Miss Annie J. Cannon's description of stars with pure continuous spectra — without either emission lines or absorption lines.

Whatever Greenstein's detailed study of his spectrogram may reveal, it is improbable, at this time, that we can accept the temperature of 350,000° found from the color index. At such an enormous temperature the atoms of hydrogen and helium would be completely ionized, and no absorption lines of these elements should be visible, at least from the revers-

ing layer of the star. There might be a higher layer of low density, something like a shell, in which the ionization is reduced. But we should ordinarily expect that such a shell would produce sharp absorption lines, and in addition there would be some strong emission lines. In reality, the absorption lines are diffuse, and there are no emission lines at all.

Before we can conclude consideration of the hottest stars, we must turn our attention to an entirely different group of celestial objects. These are the planetary nebulae, of which the best-known example is the Ring nebula in Lyra, shown in the back-cover photograph. When seen through small telescopes, these nebulae resemble the disks of planets, hence, their designation. In reality, each planetary is thousands of times larger than the solar system.

In many planetaries, and perhaps in all, there is a faint, white-blue star near the center of the diffuse, nebulous disk. In some strange way, the central star seems to impart its light to the nebula. The latter shines not by reflection, as do some dust clouds in the Milky Way (see "Clouds with Silver Linings," *Sky and Telescope,* August, 1951), but by a process known as the Zanstra-Menzel mechanism. The central stars are hot and contain much light in the invisible ultraviolet portion of the spectrum. As we shall find next month, they, too, appear to be among the hottest stars.

(*To be concluded*)

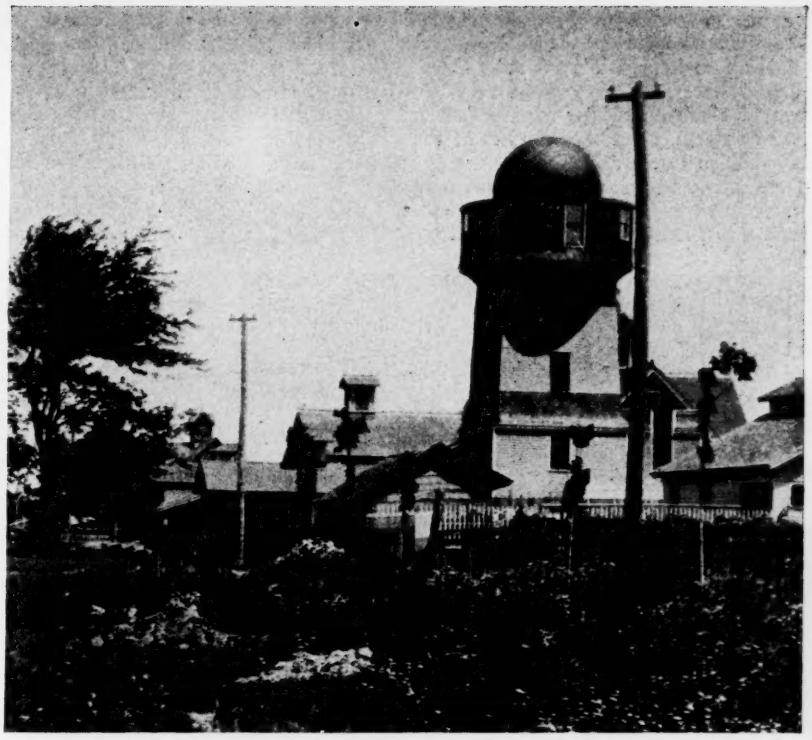
A BUDGET FOR ASTRONOMY

(Continued from page 54)

for measurement and analysis of data will permit an effective expansion of research to be obtained with minimum of cost and delay.

"Care should be exercised in the administration of funds so that universities would continue to carry their proper share in the support of astronomical research and should not use the proposed grants from the National Science Foundation to escape the expenditures for astronomy that they would otherwise make.

"Large increases in the rate of astronomical research will require much greater funds than are proposed here, and in the first year no provision is made for beginning any such expansion. Such an expanded program can be achieved over a period of many years, as the number of trained astronomers gradually increases. Our present estimate of requirements in longer-term grants for urgently needed expansion of capital equipment is an additional $200,000 per annum. This is omitted from the present budget because of the immediate need for training and rehabilitation."



The Hequembourg Observatory, built in a pasture lot in 1897. The foreground is now a paved residence street.

THE OBSERVATORY KEY

By Hilda M. Hequembourg

IN AN OLD desk drawer is a long flat key with notched edges. It was the key to our observatory in Dunkirk, N.Y. The lock on the entrance door was a new invention and could be opened by an electric push button from the top of the tower. The building was designed and constructed by father, Charles Ezra Hequembourg.

My brother, Max, and I grew up with the observatory. In the spring of 1895, we were playing in the pasture lot watching the work of construction. The standard for the telescope, a round yellow brick pier measuring five feet at the base, stood 45 feet high. It tapered to three feet at the top. A millstone eight inches thick was on the ground tied with rope ready to be hoisted up to cover the hollow shaft. Father, standing in the sunshine by the iron door which opened into the pier, called to us:

"I want you to step inside, close the door tight, count 60 and then look up. You will see something which you will never forget."

Entering, we found ourselves in complete darkness. We counted and then looked up. We saw a star twinkling in the dark blue background of the zenith.

"A star in the daytime!" Max shouted as we came tumbling out.

A square four-story tower with plate-glass windows was built around the pier. In order to protect the telescope from outside vibrations, no part of the building touched the pier. Circular strips of heavy felt were laid between the hardwood floors of each story and the brick. Picturesque wide pine stairs led up the east and south sides of the first floor, two stories high. The solid balustrade had a four-inch handrail which was slightly curved and polished like velvet. The next floor had a red window and sink for photographic work. A ship stairs led out from the third floor library to the gallery above. Here were eight long windows and a door leading to the dome room.

The bronze dome turned on an iron track which had ball bearings as large as billiard balls. The circular dome room was paneled in pine like the rest of the building and lighted with electricity. Mounted on the pier was the long telescope, the latest make. It had a 9-inch lens and long steel hand levers with ebony handles; the telescope was 25 feet long.

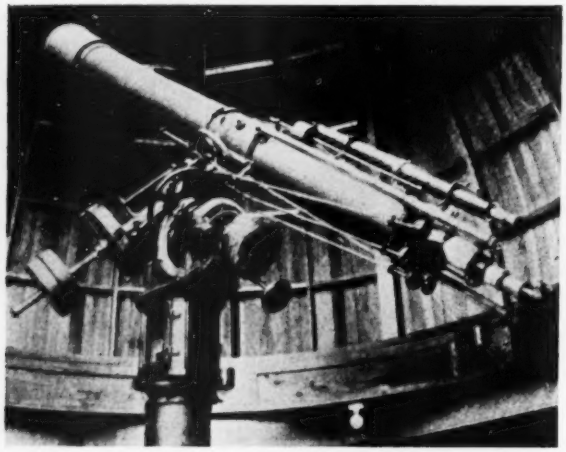
When the observatory was completed in March, 1897, Professor William Brooks, of the Smith Observatory, Geneva, N.Y., gave a lecture in Dunkirk. He pronounced our observatory the finest private one he had ever seen.

All the family enjoyed an evening of stargazing. Max and I operated the

machinery which opened the long curved doors of the dome and moved the round floor up or down, while our older sisters helped father adjust the telescope. We would climb on a high stool and look with amazement at the wonders of the sky hidden to the naked eye.

In 1900, father built an addition to the tower for Max. The ground floor was a conservatory and the upper floor, called the sidereal room, had a long flat roof where a door could be opened down the center and sides for transit observations. Here were large cabinets for valuable clocks and instruments. Soon after this room was completed, father had a serious fall and was not allowed to climb the stairs to his telescope.

His four daughters graduated from Vassar College and he hoped that the mantle of Maria Mitchell might fall on one of them. We were too late at Vassar to know Miss Mitchell, but Prof. Mary Whitney followed her famous teacher's program. We spent many clear evenings on the Vassar observatory roof watching the sky. We used long folding chairs, oil lamps to read our star charts, woolen rugs, mittens and caps. Miss Whitney's assistant, Dr. Caroline E. Furness, whose work with variable stars is well known, urged me to make the best of my unusual opportunities at home.



An early photograph of the 9-inch refractor originally installed at the Hequembourg Observatory, now at Mount Union College.

In 1907, Max, a junior in the 1908 engineering class at Cornell University, died of fever, and father, brokenhearted, passed away a few months later. Our older sisters were married; my sister Jessie and I worked alone in the observatory. She was a natural mathematician. At Vassar, she was known as the girl who lived in a tower with many sisters. Unfortunately, mother objected to our work at night and took us abroad. When our gardener and caretaker had a stroke, the building became deserted and filled with cobwebs.

After one advertisement in the *Scientific American*, Mr. Harrold, of Leetonia, Ohio, bought the building and all its contents. He opened an observatory in 1914 with an excellent public program for Leetonia. At his death, the instrument was moved to Alliance, Ohio, where it is now at the Clarke Observatory of Mount Union College.

The observatory key reminds me that I have an inner happiness due to the past companionship of two amateur astronomers, my father and my brother.

Charles Ezra Hequembourg, pioneer in natural gas development, as he appeared in 1902.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.
SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.
SCHEDULE: Tuesday through Friday, 3 and 4 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. In charge, John Patterson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.
SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.
SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.
SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.
SCHEDULE: Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.
SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.
SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.
SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.
SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.
SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.
SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.
SCHEDULE: Sunday, 4:00 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

TERMINOLOGY TALKS- J. Hugh Pruett

Meteorite Designations by Location

Since around the year 1800, when scientists in general first became convinced that "stones fall from the sky," the number of authenticated meteoritic "falls" and "finds" has nearly passed the 1,500 mark. Naturally, the simplest way to designate such an object is to give the name of the town or locality near where the remnants were recovered. In this way we speak of the Willamette (Ore.) meteorite, the Weston (Conn.) shower, the Springwater (Sask.) siderolite.

Numerical Designations

About 10 years ago, a numerical designation for meteoritic falls was proposed by Frederick C. Leonard, professor of astronomy in the University of California at Los Angeles and editor and ex-president of the Meteoritical Society (*Popular Astronomy, 49,* 214-15, 1941). In that article, Dr. Leonard mentioned the 6-digit method long in use at Harvard College Observatory for designating variable stars. The first four digits give the star's right ascension to the nearest minute of time, while the remaining two indicate its declination to the nearest degree.

Following this general plan, Dr. Leonard presented a 7-digit system of designating the place of fall of a meteorite. The Canyon Diablo (Ariz.) fall would be indicated by the number 1110,350. This means that the location is at west longitude 111°.0 and at north latitude 35°.0. The plan has since been somewhat modified, and, at my request, Dr. Leonard has sent me the final form of his system, here given in his own words.

Equatorial Co-ordinate Numbers

"Equatorial co-ordinate numbers (ECN's) are used to designate the places of fall of meteorites. An ECN is defined generally as a $(2n - 1)$-digit number (n being an integer equal to or greater than 3), of which the first n digits give the longitude, and the last $(n - 1)$ digits the latitude of the place of fall, each to the closest 10^{3-n} [10 to the $(3 - n)$th power] degree. Usually 7-digit ECN's are employed, although ECN's composed of any *odd* number of digits, equal to or greater than 5, can, of course, be used. In the case, for example, of a 7-digit ECN, the first four digits give the longitude, and the last three digits the latitude of the place of fall of the meteorite, each to the closest tenth of a degree.

"It is obvious that the ECN must carry some sort of sign, in order that west and east longitudes, and north and south latitudes, respectively, can be differentiated from each other — that is, in order that the *quadrant* of the Earth's surface, in which the place of fall is located, can be uniquely determined. If the longitude is west (positive) and the latitude is north (positive), a plus (+) sign precedes the number; if the longitude is west (positive) and the latitude is south (negative), a plus-minus (±) sign; if the longitude is east (negative) and the latitude is north (positive), a minus-plus (∓) sign; and, finally, if the longitude is east (negative) and the latitude is south (negative), a minus (−) sign. For example, the 7-digit ECN of the famous Barringer Meteorite Crater, near Canyon Diablo, Ariz., is +1110,350; that of the well-known stony-iron fall of Imilac, Desert of Atacama, Antofagasta, Chile, is ±0602,238; that of the historic stone fall at Ensisheim, Alsace, France, is ∓0074,479; and that of the great iron meteorite at Hoba West, near Grootfontein, Southwest Africa, is −0179,196.

"If two or more falls have the same ECN, they can readily be distinguished from one another by means of capital letters following their common ECN, assigned alphabetically in the order of discovery of the falls; for example, +1110,350A; +1110,350B; and so on.

"If even the 7-digit ECN of a meteoritic fall be known, the place of fall can be located forthwith on a map, with an accuracy of a tenth of a degree in each co-ordinate, which corresponds to a distance on the Earth's surface of seven miles or less.

"ECN's, because of their usefulness and simplicity, are an indispensable tool in all positional problems in meteoritics, and they are serviceable also as catalogue and reference numbers for meteoritic falls."

LETTER TO THE EDITOR

Sir:

In Terminology Talks, March, 1951, under "The Week," I read, "We readily recognize the planetary origin of the names. . . ."

But was there any reason, cause, or rule to arrange the names of the days in alternate order of one outer and one inner planet? For example, after Moon, **Dies Lunae,** the outer planet Mars is taken for **Dies Martis;** the inner planet Mercury is for **Dies Mercurii,** then the outer planet Jupiter for **Dies Jovis.** Venus was taken for **Dies Veneris,** and next Saturn as **Dies Saturni.**

The moon is the inner bright orb at new moon and the outer one at full moon; therefore I assume **Dies Lunae** after **Dies Solis.** But for the others? I shall be glad if anybody could find out the cause.

R. G. CHANDRA
Sarkarbati, Sukchar P.O.
24 Parganas Dist.
India (West Bengal)

A New Planetarium for Uruguay

A large planetarium is being incorporated into the Centro de Divulgacion Cientifica, a new science museum now being constructed in the city of Montevideo, Uruguay. The projection instrument will be constructed by the Spitz Laboratories, Inc., of Philadelphia, in accordance with a contract recently signed by the Hon. German Barbato, mayor of Montevideo, and Professor Felix Cernuschi, who represented the Spitz Laboratories. Professor Cernuschi has been a Guggenheim fellow at Harvard University, and was author of the series of articles in *Sky and Telescope,* "Cosmogonical Implications of the Atomic Bomb," V, 1-5, 1945-1946.

The new planetarium projector will be the first such instrument in South America and the first large planetarium ever to be built by any commercial firm outside Germany, according to Armand N. Spitz, who is the inventor of the Spitz projector Model A. "The new instrument," he stated, "has been designed to equal or exceed in performance the Zeiss projector, but it is not a copy of the German planetarium. It does essentially the same things, and does many of them far better, but the basic principles of its operation are different in many respects. Our improved design makes possible an initial cost which is half of the prewar price of the Zeiss instrument."

Like its small predecessor, the Spitz Model B will employ pinhole projection for most of its stars, its light source being especially manufactured to produce images of the proper characteristics. Stars brighter than magnitude 2.01 will each have a separate optical concentrator, thereby procuring small images in spite of increased brightnesses. The projector's height set for polar latitudes will be approximately 12 feet; at other latitudes, 10 feet; horizon level, eight feet. The total weight will be about 1,100 pounds, which is expected to reduce considerably the cost of operation and maintenance; the maximum power requirement will be one kilowatt.

By contrast, the inexpensive Spitz Model A stands only three feet high and weighs about 25 pounds. It was originally conceived in 1936, when Mr. Spitz sought to make a simple device to project star patterns on the ceiling of his daughter's bedroom; 10 years were required before the production model could be achieved. At present there are nearly 70 Spitz projectors in use, 11 of these outside the United States. The United States military and maritime services have a dozen instruments in operation, chiefly at Air Force bases and Naval Air stations. Twenty-six educational institutions and 16 museums own and operate Spitz instruments.

Amateur Astronomers

NEW CLUB IN LAS CRUCES

A meeting was held this fall at the home of Mr. and Mrs. Clyde W. Tombaugh, attended by 20 persons, to organize the Astronomical Society of Las Cruces, New Mexico. The group is made up of personnel from the Harvard meteor stations, White Sands Proving Ground, New Mexico A. and M. A. College, and interested amateurs. The society may later include interested persons from Holloman Air Force Base and the Harvard solar station on Sacramento Peak, both of which are some 75 miles to the northeast of Las Cruces.

Subjects for meetings include the history of astronomy from ancient times to the present, telescope making, and the techniques of planetary, lunar, and meteor observing. Serious organized observing is planned, in addition to the professional work done by some of the members. The skies of the vicinity are especially favorable to astronomical work.

The officers are: president, Mr. Tombaugh; first vice-president, Philip Carroll; second vice-president, J. E. Durrenberger; secretary, Mrs. Cecil Post. Meetings are to be held on the first Saturday evening of each month, in the homes of members. Further information may be had from Mr. Tombaugh at 636 S. Alameda St., Las Cruces, N. M.

FLORIDA SOCIETY ORGANIZED

The Gulfstream Astronomical Association, Inc., with headquarters in Miami Springs, Fla., had its inception at a public meeting in March, 1951, called to ascertain whether in this area there might be sufficient interest in the erection of a planetarium. Originators of the movement were George H. Lutz, a winter resident, and Dr. Russell H. Williams. Our objectives include the mutual improvement and education of our members in the science of astronomy, the promotion of college and university scholarships, and a campaign to interest a sponsor in providing funds for a planetarium for the University of Miami. We contemplate for the future the completion of a telescope to utilize the Lutz metal mirror.

In addition to taking **Sky and Telescope** for all our members, we are applying for membership in the Astronomical League.

At our first annual business meeting in November, the following were elected: president, Larry F. Higgins; vice-president, E. Downey Funck; secretary, Dorothy D. Higgins; treasurer, George P. Norris; corresponding secretary, Leonard G. Pardue. Further information may be had from the undersigned.

LEONARD G. PARDUE
631 Falcon Ave.
Miami Springs, Fla.

CONVENTION AT MUNICH

An international convention of planetary observers, sponsored by the planet section of the amateur association, Bund der Sternfreunde, was held at Munich, Germany, in August, 1951. More than 70 delegates from European and other countries were present.

A four-day program included visits to the University of Munich Observatory, the Zeiss planetarium, the astronomy and physics departments of the Deutsche Museum, the Wendelstein high-altitude solar observatory, and the exhibit on amateur astronomy at the Bavarian chamber of trade. There were three scientific paper sessions, on amateur telescopics, adult and youth education, current research on the major planets, and astrophysics. A public lecture on Mars was given by the chairman and director of the planet section, E. L. Pfannenschmidt, at the U. S. Information Center, Amerika Haus, Munich.

The planet section plans translating the papers read at the convention. Inquiries may be addressed to E. L. Pfannenschmidt, Grimsehl Strasse 18, (20b) Einbeck-Hannover, British Zone, Germany.

ASTRONOMY IN PERU

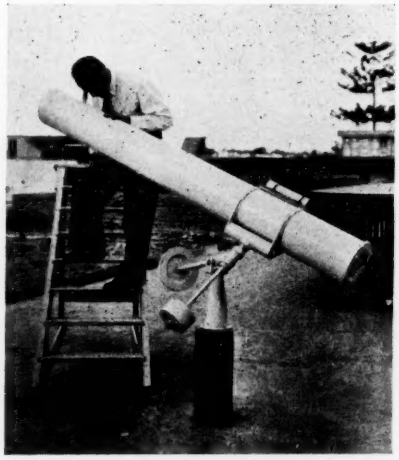
The **Asociacion Peruana de Astronomia** was founded in Lima, Peru, in August, 1946, and is now an active group led by its president, Victor A. Estremadoyro. Plans are under way for the construction of a society observatory, and already the government has granted about three quarters of an acre of land for the venture in the Morro Solar, Chorrillos, a suburb of Lima.

Mr. Estremadoyro is pictured here with an 8-inch reflector of his own construction, the first instrument of this type to be built in Peru. It has a focal length of about 64 inches, and the experience gained in making and operating it is expected to prove invaluable in the society's observatory project. It is now being housed in a building with a revolving dome about 14 feet in diameter, at Mr. Estremadoyro's home in Chorrillos.

The association has an observing program. Mr. Estremadoyro and his brother, Gustavo, are regular observers of variable stars for the AAVSO, and of sunspot activity for the Solar Division of the AAVSO.

When the UNESCO traveling astronomy exhibit was on display in Lima in September, 1950, the Peruvian Astronomy Association had charge of the operation and demonstrating of the Spitz planetarium, which was set up in a portable projection dome.

A monthly bulletin has been published in mimeographed form for many years, in Spanish, chiefly the work of Mr. Estremadoyro and Ing. Alfredo Araujo Alvarez.



Victor A. Estremadoyro and his 8-inch reflecting telescope. Note the small inclination of the polar axis, set for a latitude of about 12° south.

THIS MONTH'S MEETINGS

Buffalo, N. Y.: Amateur Telescope Makers and Observers. Jan. 2, 8 p.m., Museum of Science. Walter Semerau, "Monochromators and Other Gadgets."

Cambridge, Mass.: Bond Astronomical Club. Jan. 3, 8:15 p.m., Harvard Observatory. Charles A. Federer, Jr., Harvard Observatory, "The AAS Meeting in Cleveland."

Cleveland, Ohio: Cleveland Astronomical Society. Jan. 18, 8 p.m., Warner and Swasey Observatory. Dr. Robert R. McMath, McMath-Hulbert Observatory, "The Sun in Action."

Dallas, Tex.: Texas Astronomical Society. Jan. 28, 8 p.m., Dallas Power and Light Co. auditorium. Film, "Navigation — The Earth."

Denver, Colo.: Denver Astronomical Society. Jan. 14, 8 p.m., Chamberlin Observatory. Astronomical instruments section program. Jan. 28, 8 p.m., Chamberlin Observatory. T. J. Bartlett, Chamberlin Observatory, lecture.

Geneva, Ill.: Fox Valley Astronomical Society. Jan. 8, 8 p.m., Geneva City Hall. "Astronomical Picture Reel," Frank Hancock, book reviews.

Greensboro, N. C.: Greensboro Astronomy Club. Jan. 9, 8 p.m., Science Building, Woman's College. L. P. McLendon, Jr., "Navigation by the Stars."

Lorain, Ohio: Black River Astronomical Society, Lorain-Elyria. Jan. 8, 7:30, Lorain YMCA. George Diedrich, "Celestial Identification."

Madison, Wis.: Madison Astronomical Society. Jan. 9, 8 p.m., Washburn Observatory. Dr. A. E. Whitford, Washburn Observatory, "Colors in the Sky."

Minneapolis, Minn.: Minneapolis Astronomy Club. Jan. 9, 7:30, Library Science Museum. Wensell Frantzich, "Unusual Phenomena in the Lower Atmosphere." Jan. 23, 7:30, Macalester College, St. Paul. Dr. Waldo Glock, "Origin of the Solar System."

New York, N.Y.: Amateur Astronomers Association. Jan. 2, 8 p.m., American Museum of Natural History. Earle B. Brown, "Recent Advances in Astronomical Equipment."

Rutherford, N.J.: Astronomical Society of Rutherford. Jan. 3, 8 p.m., YMCA. Symposium, "Rockets and Space Travel."

Washington, D. C.: National Capital Astronomers. Jan. 5, 8:15 p.m., Department of Commerce auditorium. Thomas N. Gautier, Jr., Central Radio Propagation Laboratory, National Bureau of Standards, "Radio Studies of Meteors."

Ungava Crater from the Air

By Squadron Leader W. K. Carr, *DFC, RCAF*

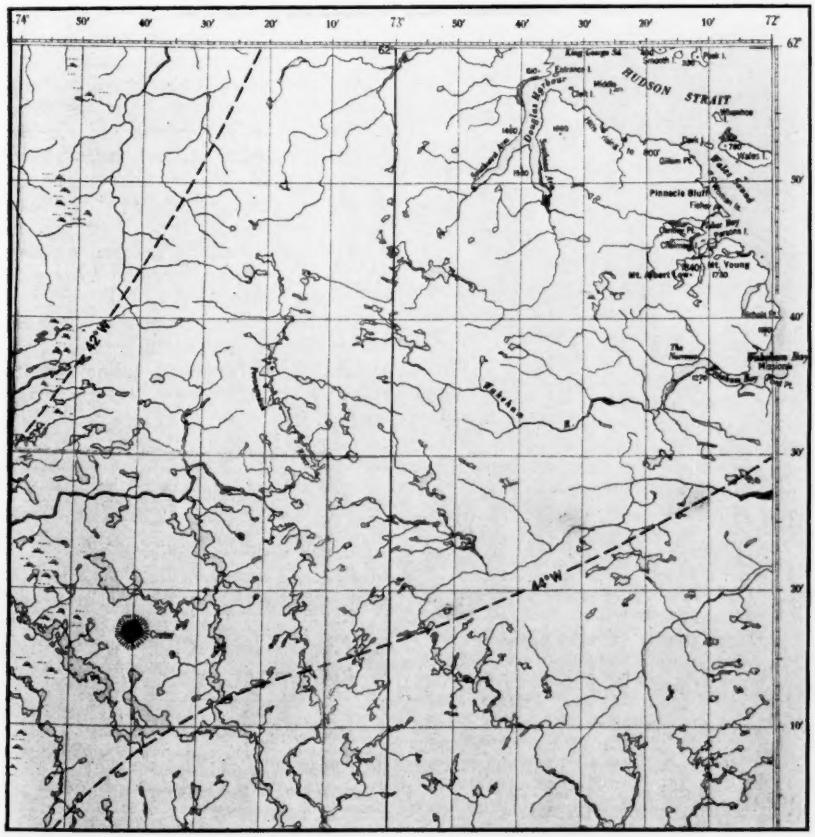
I FIRST SAW the Ungava crater about the 28th of June, 1946, while flying a float-equipped Norseman aircraft in the Ungava district of northern Quebec. At that time I was in charge of a flight of Norseman aircraft engaged in the transportation of personnel from the Geodetic Service of the Department of Mines and Technical Surveys of Canada, who were in the area to obtain astronomical fixes which were later used in the positioning and scaling of aerial photographs.

This was a small but essential part, at that time, of possibly the largest aerial mapping program ever undertaken by any country. Until then, vast areas of northern Canada (approximately 2½ million square miles) had never been "adequately" mapped. (I use "adequately" from the airman's point of view — accurate 8-miles-to-the-inch coverage.) Of this vast amount of land, approximately 1,750,000 square miles had never been mapped at all. Numerous 8-miles-to-the-inch map sheets had been published with nothing but parallels of latitude and longitude and in bold type "unmapped" printed across them. I would say, from my relative familiarity with the major part of Canada's North, that taken as a whole the Ungava district was the poorest mapped area on the mainland.

The Ungava crater first appeared as a bit of detail on a very inaccurate 16-miles-to-1-inch chart issued in 1942. The information for this map was obtained from a tri-camera photographic run done during the winter of 1941-42 along the west coast of Ungava Bay. The limit of plottable data in the photographs was along a line which just included the crater. When the map was drawn up, a small round lake on it was identified with the word "crater."

Flying in unmapped country where there are no aids to navigation (not even a navigator), a pilot quickly learns that there are only two ways to keep from getting lost: Stay on the ground, or remember features of the land over which he flies. In the northern latitudes of Canada, compasses are not reliable and often do not work. Therefore, the pilot quickly develops this facility and in flight is always mentally recording outstanding features of the terrain. The Ungava crater is one of these features.

A nearly vertical view of the southeast rim of the Ungava crater, taken from about 1,000 feet. The November, 1951, cover picture is a view of the entire crater, which probably is of meteoritic origin. Royal Canadian Air Force photograph.



Part of the 1949 edition, Povungnituk River map, Canadian Department of Mines and Technical Surveys; reproduction scale, about 16 miles to the inch.

The crater is located near the edge of a greenstone area in the great pre-Cambrian shield. The surrounding country is mostly barren and flat with scattered rocks deposited by the receding ice cap. Along the edges of the thousands of shallow lakes and numerous streams and rivers grow many species of arctic flora.

After having flown back and forth across the area several times, I was returning to base camp, that day in 1946, from delivering a geodetic party to a lake approximately 300 miles north, when I ran into what appeared to be a line squall. I decided the best thing to do was to land in some lake and wait for the squall to pass by. I happened to be a few miles from the crater so altered course and did a "dummy run" over it, after which I landed and tied up to the northeast shore. I stayed on the lake about two hours.

From the inside the lake appeared to be the result of a big "splash" of some sort. The sides extended a good 100 to 200 feet above the surrounding terrain, particularly along the south to southwest side, and the lake appeared about two miles in diameter. The walls were very steep, yet in places they were a mass of tumbled rocks. The lake was obviously fairly deep. It definitely did not appear volcanic in origin, nor was it similar to any of the other lakes in the region.

After I returned to base camp we quite often discussed the crater and its

(Continued on page 62)

NEWS NOTES

By Dorrit Hoffleit

FIVE HUNDRED SOLAR FLARES

"Solar flares seem possessed of a peculiar and fascinating perversity. The more we learn about them, the harder they are to understand, and the sharper the appetite for more information becomes." Thus begins Dr. John W. Evans' description of the methods, trials and tribulations of building and operating a solar-flare recorder that is now in daily operation at the Sacramento Peak station of Harvard College Observatory, published in *Science* for November 23, 1951.

An experimental model flare recorder, employing a typical Evans birefringent filter in combination with a calcite filter unit, was put into operation at the High Altitude Observatory headquarters in Boulder, Colo., and in nine months recorded 252 solar flares. The improved recorder at Sacramento Peak has been in operation since March, 1951, and by September 1st also had observed 252 flares. It records a complete picture of the sun in hydrogen-alpha light once a minute on 35-mm. film throughout cloud-free periods of each day. The films are developed at night and measured the following morning. The resulting data is telegraphed to the National Bureau of Standards at Washington, to be used in studies of solar-terrestrial relationships.

The flares occur at present about one every eight hours. Dr. Evans points out the need for additional instruments of this type at well-distributed longitudes around the world. Already a photographic flare recorder is being constructed in Sydney, Australia, where the sun can be observed when it is below the horizon in the Rockies.

DOMINION ASTROPHYSICAL OBSERVATORY

A two-story addition to the offices and laboratories is scheduled for construction at the Dominion Astrophysical Observatory, Victoria, B.C. The proposed addition will more than double the present building, constructed in 1924. In addition to meeting the demands of a larger staff, the new building will house seismological equipment and provide facilities for some laboratory and spectroscopic investigations. It is hoped that construction will be partially completed at the time of the forthcoming meeting of the American Astronomical Society at Victoria, June 25-28, 1952.

The direction of the observatory and its scientific programs has been assumed by Dr. R. M. Petrie, who succeeded Dr. J. A. Pearce on August 1, 1951. Dr. Pearce remains on the observatory staff, devoting his time entirely to the completion of his spectroscopic researches. Dr. Andrew McKellar has become assistant to the director, and is in charge of the extension of the instrumental facilities for use with the 73-inch reflector, for which an entirely new stellar spectrograph is nearing completion.

MORE ON RADIO STARS

Nature reports further results from the Cavendish Laboratory, Cambridge, England, on radio stars. F. C. Smith gives positions accurate to 10 minutes of arc or better of four of the brightest of these objects, measured with a special interferometer and wave lengths of 3.7 and 1.4 meters:

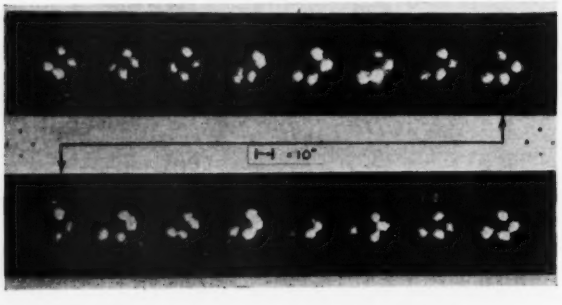
Constellation	*R. A.*	*Dec.*
Taurus	$5^h\ 31^m\ 34^s.5$	22° 04′
Virgo	12 28 18	12 37
Cygnus	19 57 45.3	40 35.0
Cassiopeia	23 21 12.0	58 32.1

M. Ryle and B. Elsmore, working at 3.7 meters with the same interferometer, conclude that none of the hundred known radio stars in the northern hemisphere of the sky varies by more than 0.1 magnitude with any period shorter than about a thousand days. Observations were made nearly every day for a period of 18 months. The authors comment on this result in comparison with the behavior of visible stars and with the marked day-to-day variations in the intensity of meter-length radiation from the sun.

SCINTILLATION OF STARLIGHT

Seeing has become a popular subject among professional astronomers. Not only is it important in astronomical observations, but it promises to provide information on the features and behavior of the atmosphere. A paper on the scintillation of the stars appears in a recent issue of the *Journal* of the Optical Society of America (October, 1951), by A. H. Mikesell, A. A. Hoag, and John S. Hall, of the U. S. Naval Observatory. Their observations were made in Washington and at the Lowell Observatory, Flagstaff, Ariz.

This paper deals primarily with changes in brightness due to seeing. Both photoelectric and photographic techniques were used, the latter involving motion-picture photographs of shadow bands on a 40-inch mirror and of Hartmann images obtained simultaneously through four widely separated apertures in front of that mirror. These out-of-focus images, which for steady seeing would have shown four spots of equal brightness arranged, like the apertures, at the four corners of a diamond, in bad seeing showed widely differing configurations from frame to frame (at 16 frames a second, 1/50 second exposure). In fact, in a few cases three or five images instead of four are seen.



Change of place, change of focus, and scintillation are shown by these motion pictures of Hartmann images of Sirius. The two negative patterns between the rows are images of Arcturus formed by the same apertures under good seeing conditions. U. S. Naval Observatory photograph.

IN THE CURRENT JOURNALS

NATURE NOTES AT UNGAVA CRATER, by Robert C. Hermes, **Canadian Nature,** November - December, 1951. "It was my photography that procured for me the chance to make a thrilling 3,500 mile flight into the sub-Arctic and to be one of the first to see with my own eyes the largest meteorite crater yet known."

THE ASTRONOMER'S MOST USEFUL CHART, The Bonner Durchmusterung, by Cora G. Burwell, **Leaflet** No. 271, Astronomical Society of the Pacific, November, 1951. "After more than half a century of celestial photography it is perhaps surprising that our most useful astronomical chart is one made a hundred years ago by hand from visual observations."

THE MOTION OF THE MOON, by Paul E. Wylie, **Popular Astronomy,** November, 1951. "Our elementary discussion of the motion of the Moon has produced only qualitative results. These results may be useful in more advanced study, or, for some, they may suffice."

UNGAVA CRATER FROM THE AIR

(Continued from page 61)

origin.* Throughout the summer the other pilots and myself continued to use the crater as a landmark. It was particularly good as such during conditions of low ceilings because the rim could be seen from a distance of 20 to 30 miles.

**Arctic Unfolding*, by Nicholas Polunin, Hutchinson & Co., Ltd., London, 1949, page 198: ". . . Jake told me of a 'crater' he had flown over and photographed a few days previously in north-eastern Ungava, near the headwaters of the Povungnituk River. It was the better of three miles across, had a considerable lake in the centre, and looked as though it had been caused by some vast explosion or at least impact."

BOOKS AND THE SKY

A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY
Volume I: The Classical Theories

Sir Edmund Whittaker. Thomas Nelson and Sons, New York, 1951. 434 pages. 32s 6d.

THE SEVERE TITLE of Sir Edmund Whittaker's book hardly prepares the reader for the engrossing survey he has written. He traces the development of theories of light and electricity from the earliest times to the beginning of the 20th century. At first the two streams of thought run independently, and the narrative moves back and forth between them. With Faraday they begin to unite, and Clerk Maxwell converges them into a single channel. Classical radiation theory flows on toward the age of Lorentz, and the book carries it to the verge of quantum theory.

A student who has been introduced to the subject — and most of us were — by the study of the electromagnetic theory of light, as formulated by Maxwell and developed by Lorentz, has no conception of the slow growth of which it was the culmination. For example, since Thomas Young first suggested in 1817 that light consists of transverse vibrations, the relation of the direction of vibration to the plane of polarization of the light has been a recurrent problem. Fresnel believed that the displacement was perpendicular to the plane of polarization; MacCullagh and Neumann considered that it was parallel; Cauchy and Green each produced two theories which involved the two alternative possibilities. A student who has merely learned that, on Maxwell's theory, the plane of polarization is parallel to the magnetic vector, and perpendicular to the electric vector, cannot fully appreciate the problem. His understanding is deepened through a study of the slow steps by which the final decision was reached.

Equally interesting is the slow solution of the questions: What carries the electric current through a wire? And what are the bearers of the charges in electrolysis? Equally revealing is the history of the study of the electrical, thermal, and optical properties of metals, and their eventual convergence; and the gradual development of understanding of the optical behavior of crystals.

Among the many contributors to the growth of electromagnetic theory, Fresnel, Faraday, and Maxwell seem to stand out as major heroes of the narrative. Lord Kelvin, despite his stature, appears as an oddly disappointing figure, reluctant to the last to accept the Maxwellian idea of equipartition of energy. Helmholtz, Hertz, and Heaviside emerge as real entities, instead of names vaguely associated with physical effects. If I do not class J. J. Thomson and H. A. Lorentz among the major heroes of the book, it is because I knew these men. They belong to the present, and it is difficult to think of them among the giants of the past, such as Euler and Laplace. Perhaps the strangest of all the figures is that of Henry Cavendish, "indifferent to fame"; one cannot help wondering how much earlier the theory of electricity might have developed if he had been emulous of the recognition of his contemporaries.

Sir Edmund writes like the mathematician that he is. The first page introduces the reader to vector notation, and in these terms all the theories are expressed. There are no diagrams, and no attempt is made to popularize the subject. The book will not appeal to a reader with no technical preparation. But it is not hard reading to one who has a background of classical physics. The reviewer found it too engrossing to be put aside before the last page had been read.

The author promises to follow the first volume with another that brings the story up to the present time. A treatment, of equal excellence, that deals with the development of quantum theory, wave mechanics, and relativity, will be something worth waiting for.

CECILIA PAYNE-GAPOSCHKIN
Harvard College Observatory

INTERPLANETARY FLIGHT

Arthur C. Clarke. Harper and Bros., New York, 1951. 164 pages. $2.50.

FEW READERS of this magazine can have failed to see news reports of military and scientific achievements in the field of rocketry and guided missiles. A two-step liquid fuel rocket attains a speed of 5,000 miles per hour and an altitude of 250 miles; a modified V-2 is fired from shipboard; man-carrying rocket planes pierce the sonic barrier; "secret" researches on satellite missiles are mentioned almost casually.

How close are we to shaking off the earth's gravity? Can we expect to visit Mars in 1970 as easily as we fly to Hawaii today? Will astronomers soon set up shop on a satellite station outside the frustrations of the atmospheric blanket? Or can we expect only an unmanned television relay station or two, hanging relentlessly overhead?

In this little book, a prominent member of the British Interplanetary Society reviews the difficulties already overcome and the problems still to be solved. More important still, in a chapter entitled "Opening Frontiers," he tries to answer the old question: "Why fly to the moon anyhow?"

The author steers a middle course between the technicalities of Oberth's **The Way to Space Travel** (published in 1929 but still a fundamental reference if one reads German) and the pleasures of Bonestell and Ley's **The Conquest of Space.** Clarke uses graphs and a little mathematics, but most of the latter he relegates to unobtrusive appendices. He serves up the latest British speculations on atomic rockets and satellite stations, mentions the problems of navigation and communication, and describes the physiological difficulties of weightlessness and radiation. It would be hard to ask for a more compact or a more up-to-date introduction to the field of astronautics.

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Graphic Time Table o

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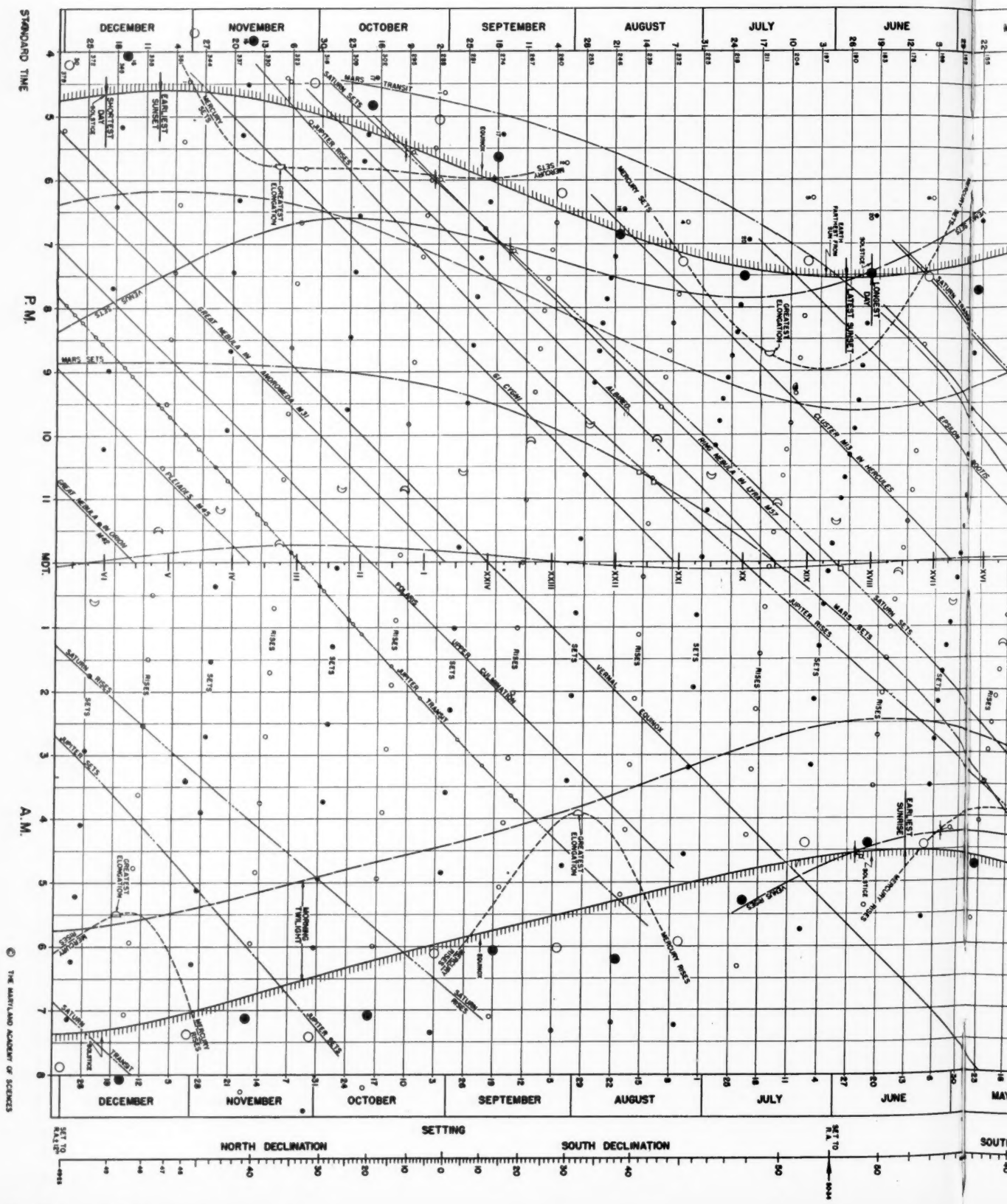

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The Graphic Time Table of the Heavens

while still available may be secured directly from the Maryland Academy of Sciences, Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., at 25 cents each; on orders of 20 or more the price is 15 cents each. The engraving of the Graphic Time Table has been lent for our use by the Maryland Academy of Sciences.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight, and the ending of evening twilight; the times when certain stars and other objects of interest transit (cross the celestial meridian); phases of the moon; the equation of time; and other astronomical information. To illustrate by an example: The events of the night of January 3-4 may be found by following the horizontal line for that date across the graph from left to right. The Julian Day number for that evening is 2,434,015. The sun sets at 4:47 p.m.; Jupiter transits or crosses the meridian at 5:36 p.m. Evening twilight ends at 6:23; Polaris transits at 6:52, the Pleiades at 8:58, and the Orion nebula at 10:46. Jupiter sets at 11:44. The curve for the equation of time indicates that the sun is slow and will not arrive at the meridian until 4 minutes after 12 o'clock noon, local time. Saturn rises 15 minutes after midnight; the moon, at first quarter, sets at 12:24 a.m., Mars rises at 12:54, Venus at 4:10, Mercury at 5:37. Morning twilight begins at 5:45; Saturn transits at 6:06; Mars transits at 6:35; the sun rises at 7:22.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon. Circles on the Jupiter transit curve indicate nights on which occultations, eclipses, or transits of Jupiter's bright moons occur between 7:00 and 11:00 p.m. EST. Small squares on planet curves indicate quadrature, and oppositions are marked by the conventional symbol.

The new scale at the right is for finding rising or setting times of other objects. Set dividers or a strip of paper from the index at the center of the scale to the given declination, north or south, and in the direction desired for either rising or setting. Measure this same distance along the midnight line of the chart beginning at the proper right ascension indicated by the Roman numerals. Should the end point fall outside the chart, add or subtract from the right ascension 12 hours and reset the dividers using the end rather than the center index of the scale. Through the point established, draw a line parallel to the vernal equinox line on the chart. This will show the time of the rising or setting of the object.

How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets are absolutely correct for only one point on the earth's surface — for this chart: latitude 40° N. and longitude 90° W. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded.

Correction for difference in longitude depends principally on the observer's distance east or west of his standard time meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

Atlanta	+38	Detroit	+32	New York	− 4
Baltimore	+ 6	Houston	+22	Pittsburgh	+20
Boston	−16	Indianapolis	−16	Rochester	+10
Chicago	−10	Kansas City	+18	San Francisco	+10
Cincinnati	+38	Los Angeles	− 7	Seattle	+10
Cleveland	+27	Milwaukee	− 8	St. Louis	+ 1
Denver	0	Minneapolis	+13	Washington	+ 8

All places with plus corrections are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given for lunar eclipses and Jupiter's satellites, and in the Far West slight corrections may be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."

The Graphic Time Table of the Heavens - - 1952

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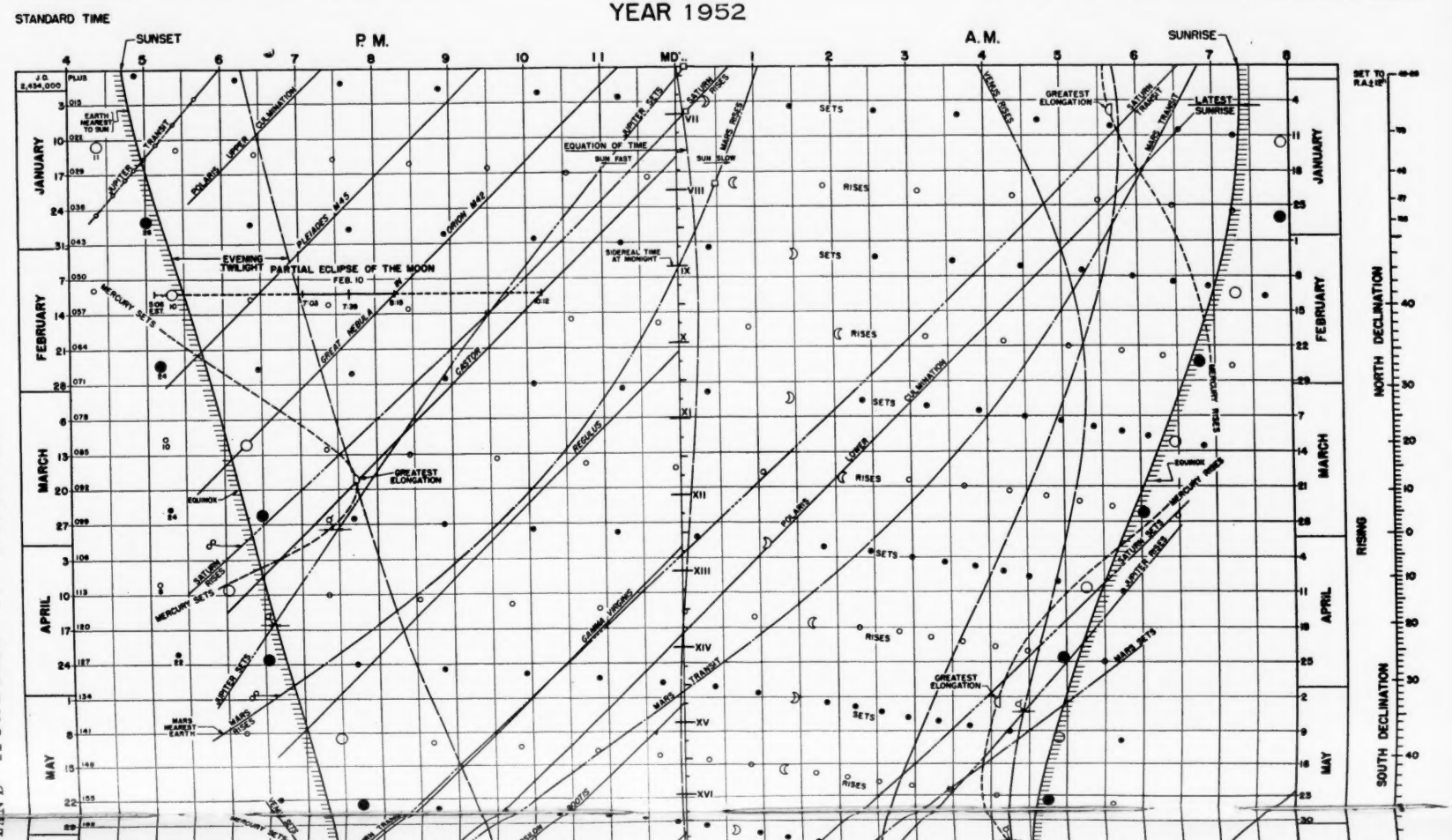

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81 mm (3 3/16")	622 mm (24½")...	22.50
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83 mm (3¼")	711 mm (28").....	28.00
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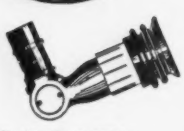

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GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Portable Reflector with Unusual Features

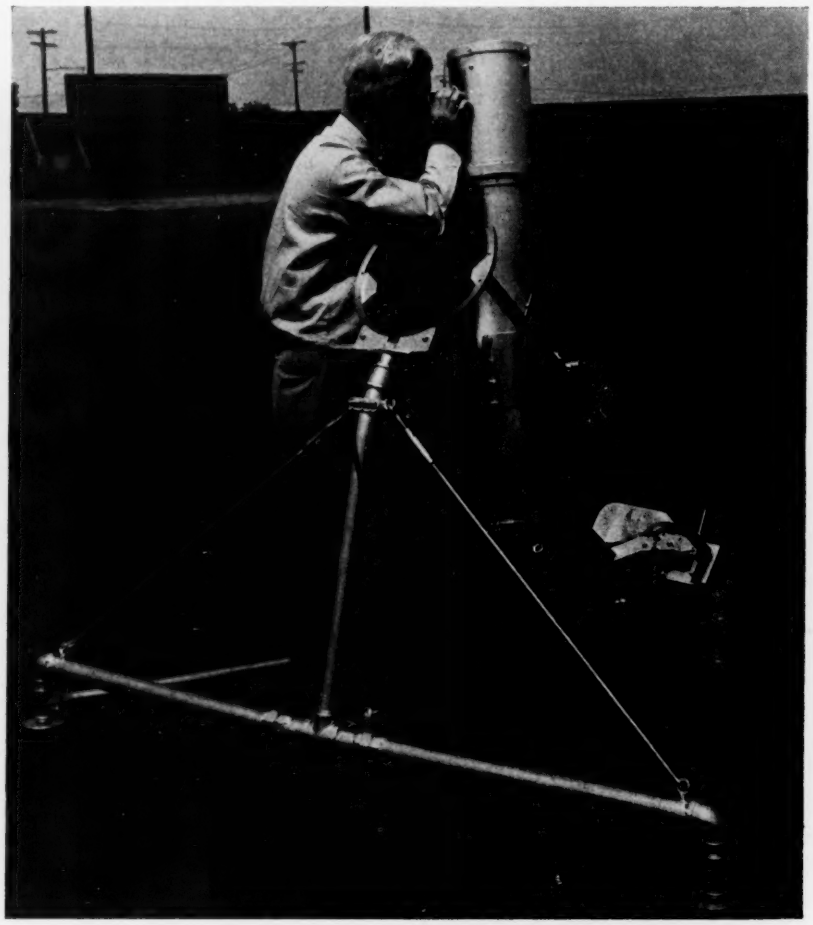
AS AN INCENTIVE for more members of the Stockton Astronomical Society to build their own telescopes, Dr. Clarence P. Custer, 47 N. Grant St., Stockton 8, Calif., built the 6-inch reflector pictured here and in disassembled form on the front cover. The instrument is a modification of the reflector designed by S. I. Gale, lecturer at the Hayden Planetarium, for use with scout camp observers and other observing groups (see **Sky and Telescope**, July, 1949, page 220). The horseshoe opening in the yoke support, similar to the horseshoe of the 200-inch telescope, is a feature of both of these portable instruments.

Mr. Gale provided Dr. Custer with the plans of his instrument. The machining was done by William R. Burnside, mainly at the Carando Machine Works in Stockton. The 6-inch mirror was Dr. Custer's first attempt at telescope optics, but he made a complete record of the polishing and parabolization in the form of focograms, which were published in **Scientific American**, August, 1950. The telescope won first prize at the western amateurs convention at San Diego in August, 1951.

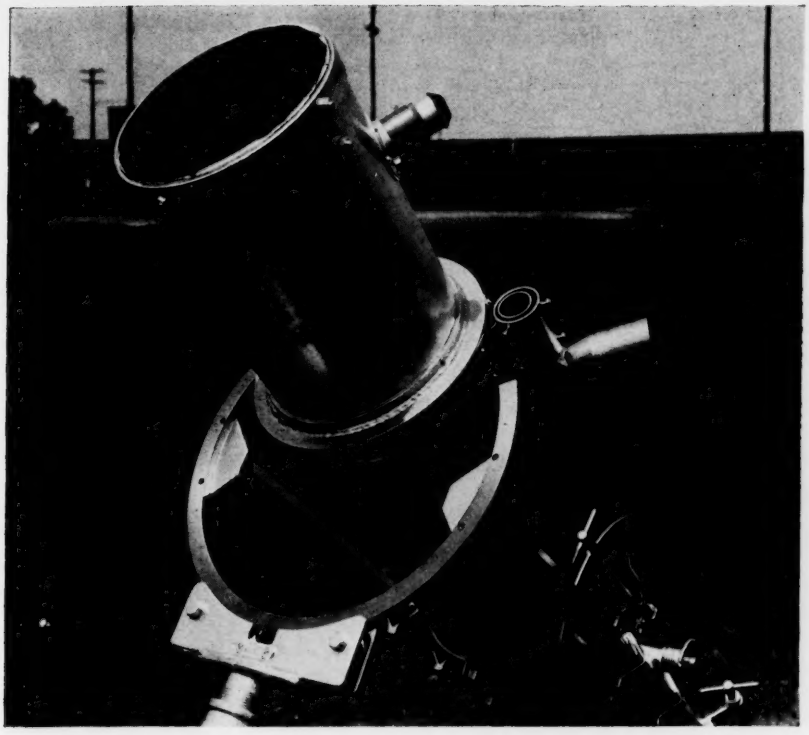
Dr. Custer calls attention to the following features, many of which are unusual in an instrument that can be taken apart easily and carried in an automobile:

Pipe-fittings construction. I made the triangular base of 1" and 1½" pipe, with a union toward the south end of each side of the long 1" sections. There are two more unions, in the 1½" north section, one on each side of the north polar support. When these are unfastened, the halves of the north section can swing parallel to the 1" sides to permit transportation (see front cover). The rounded edges of the four unions were ground to right angles to give a tight fit that would resist flexure. All the pipe junctions except the unions and the threads which permit the folding are spot-welded.

Turnbuckle rods. Two removable rods with turnbuckles tighten the top of the north polar support to the northern side of the base, preventing any lateral motion. This produces such rigidity that striking the top of the support does not make the tube vibrate. A level extending in an east-



Dr. Clarence P. Custer's 6-inch portable reflector, shown disassembled on the front cover, is here set up ready for observing. Photo by Tom McCoy.



The rotating turret carries the spider, eyepiece, and finder. Photo by Tom McCoy.

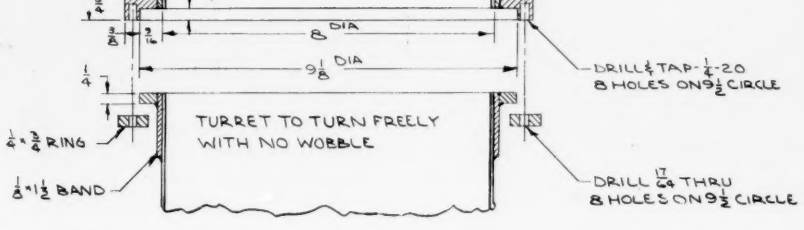
west direction near the top of the support serves as a check that the tension in the turnbuckles is equal and that the support remains in the plane of the meridian.

Leg adjustments. Of the three legs, only the two northern ones are adjustable for height. At each of these legs a pipe threaded its full length on the outside is screwed into the tee above, and onto the pipe is screwed a threaded disk about 4" wide. These disks may be turned either way to raise or lower the leg supports. Levels at the foot of the north support permit checking the level of the base in a horizontal plane.

Yoke and horseshoe bearing. The long sides of the yoke are each made from two angle irons spot-welded together to have a square cross-section. At the upper end they support the horseshoe bearing, which was originally found in the scrap pile of a machine shop. It had been accurately machined and a section removed at the top for some other purpose. Two sealed roller bearings carry the weight of the telescope at the horseshoe end. They fit in between two flat steel supports, and the horseshoe also rides against a roller bearing at the rear so it cannot slip off. At the south end, there is a base plate against which the axis is supported on ⅛" ball bearings.

Sidereal drive and slow-motion control. The sidereal drive is provided by a Bodine reversible synchronous motor of two revolutions per minute. It is classified as 1 Cat. B-8122-900 KYC22RC, 115-volt, 1800 r.p.m., enclosed ball bearing, geared to 2 r.p.m., 95-inch-ounces torque, capacitor start and run reversible motor, continuous duty. The shaft from this turns a gear with 47 teeth against one with 54 teeth, which goes through a gear box with a 25 to 1 reduction and thence through the worm to the main gear with 100 teeth. The required time for one rotation is 23 hours, 56.3 minutes; this reduction provides it in 23 hours, 56.15 minutes.

The slow-motion adjustment in right ascension consists of a conventional friction disk with a small projection on it that is



The design drawing of the rotating turret, to ¼ scale. Drawn by R. Kopping.

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moved very slowly by a threaded rod fastened to a flexible cable. The threads are very fine to provide delicate adjustments of the image in the field, in either direction. The tension needed for operation is provided by the two wing nuts that may be seen in front of the drive assembly. When these are tight, the motor drives, but the vernier adjustment permits slow-motion control whether the motor is driving or not.

The motor rides directly on the polar axis across from the counterbalance that shows on the front cover. The disk carrying the motor and weight is pinned to the other component of the friction plate, so that when the fine adjustments are made in right ascension the motor assembly rotates through a small angle also. Although mounted on the axis, these assemblies are independent of the cradle except through the worm and gear. The gear in turn drives the cradle through the friction arrangement, thus permitting a smooth and easy adjustment whether the instrument is driving or not.

A flexible cable comes up from the fine adjustment to a handle support that may be clamped on either side of the cradle. The flexible cable is permanently attached to the south end of the base, whereas when the telescope is disassembled the motor and attached gears remain with the yoke and the split ring.

A push-button switch on an electric cable is provided for convenience in controlling the motor. About 400 feet of cable, cut into sections, are for connection to a nearby power source when the motor is used in the field.

Saddle and tube with turret top. The tube lies in a permanently bolted saddle, on the sides of which are slip rings of brass. These sides are welded onto two short angle irons which can be set down onto the long angle-iron supports of the cradle. A bolt screwed into the latter on the west side prevents the short angle iron from sliding down on the longer until two square compression rings with wing nuts can be fastened to make it stay put. The tube is held at such a height that the eyepiece is at the level of one's eye when the zenith is being observed. This also permits turning the tube over when it is not in use, with the mirror end of the tube in the enclosure of the horseshoe, to keep dust off the mirror and diagonal.

The cork-lined tube was made from rolled 22-gauge iron sheeting, welded along the lengthwise junction. The upper end is an independently revolving turret that bears the diagonal support, eyepiece holder, and the finder. It is carefully machined, and permits observations from a comfortable position regardless of where the telescope is pointed. To compensate for its weight, a 16-pound lead counterweight is fastened around the mirror end of the tube. With it the instrument is perfectly balanced.

About a foot from the mirror end of the tube there is an oval hole with a screw cap. This gives access to one's hand and arm for dusting off the mirror or even for washing it in place. Furthermore, at night a flashlight can be aimed through this opening to illuminate the mirror for collimation by Redmond's method.

Optical parts and Redmond's test. The mirror is held in a triangular support of aluminum. The usual three screws for adjustment project out of the back of the mirror cell housing. The mirror itself is supported by plastic knobs that bear against its sides and back. They are all accessible by hand without removing the mirror from the housing.

The diagonal is a prism held in an eight-legged spider. There are three adjusting screws bearing on springs in the diagonal plate support. The finder is a Jaegers 3x war-surplus elbow telescope. Several sizes of threaded brass pipe are holders for eyepieces of various kinds. These pipes can be unscrewed and replaced with ease, and their threads are natural aids in focusing.

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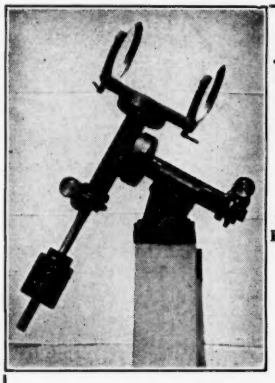

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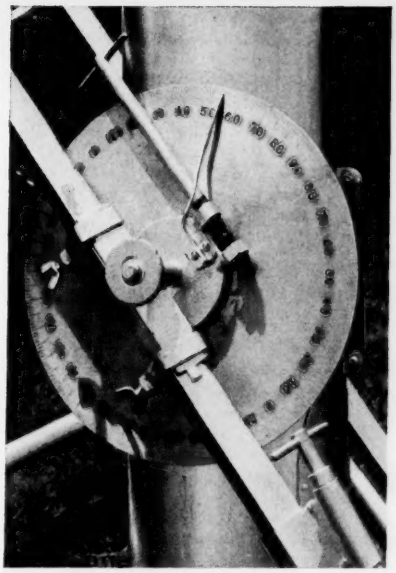
throws the optical train out of alignment, it can be checked using the method of Walter R. Redmond, Greenwood, N. Y., described in **Scientific American,** February, 1951, page 74. This requires a small area about 3/16" wide rubbed out of the exact center of the aluminized mirror surface. The area so lost does not affect the light-gathering power of the mirror as it is masked by the secondary. The eyepiece adapter tube is equipped with crosshairs, and the collimation is done by sighting in three directions: through the cleared central area of the mirror from in back of it, from in front of the tube with the secondary support removed but the spider in place, through the eyepiece adapter tube with the diagonal in place. Redmond describes a series of simple steps that can readily be employed on the spot if provision for the test is made in the instrument design.

Setting circles. The hour circle is the horseshoe itself, with divisions to 2½ minutes of time. The pointer is carried on a slotted plate in order to facilitate adjustment to the meridian. The declination circle, a 12-inch disk of aluminum marked in whole degrees, is fastened to the western side of the tube saddle. When a small hand wheel on the declination axis is tightened, a brass friction disk permits adjustment in declination by means of the slow-motion device. The handle of this vernier control can be reached while the observer is looking into the eyepiece.

Positioning problems. The three base supports of the telescope rest on small concrete blocks set below the surface of the grass of my back yard. Once the instrument is adjusted on Polaris, when that star is directly above, below, or to either side of the true pole, the outlines of the base supports can be marked on the concrete blocks with black paint. This permits quick positioning whenever the instrument is reassembled.



A closeup of the declination circle, showing the clamping handle for the friction disk. The vernier slow motion is controlled by the handle near the top of the picture; the corresponding right-ascension control is in the lower right, but may be mounted elsewhere on the yoke elements. Note the wing nuts that clamp the saddle to the yoke, and the square-top nut that determines the position of the saddle along the yoke. Photo by Tom McCoy.

I have solved the difficulty of using setting circles on a portable telescope at a star party in the following manner. The night before the party is scheduled, and while the instrument is perfectly adjusted in my back yard, Polaris is brought to the exact center of the field of view as early in the evening as it is easily visible. The declination, hour angle, and time are marked down. The following night the instrument is taken to the site of the star party, and its circles are set for the same hour angle and declination. Then, four minutes earlier than on the preceding evening, Polaris is brought to the center of the field by shifting the base east or west as required. The bubbles in the levels must, of course, all be centered. The wing nuts are tightened at the south end, the motor started, and the instrument is perfectly adjusted for the use of the setting circles throughout the ensuing observing period.

On my back-yard mounting, if a wide-angle eyepiece is left in the telescope overnight in perfect focus, I can easily pick up bright stars in the daytime if they are not too near the sun. I have set the telescope at 4:00 p.m. with Arcturus in the center of the field, with the motor running, and at 8:30 p.m. the star was still centered. Arcturus makes an especially beautiful object to observe by day, as it shines so brilliantly with its faint rosy tint against a deep blue sky.

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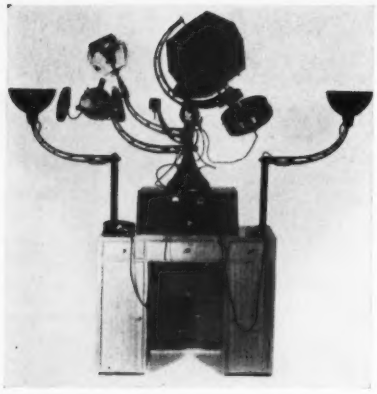

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

VISUAL OBSERVING PROGRAMS FOR AMATEURS — XXII

MOST TEXTS describe occultations of stars by the moon as being instantaneous, but when Antares was occulted in June, 1949, to me it appeared to fade gradually, as when a car headlight is turned off. This occultation took place toward the southern limb of the moon. Later calculation, based upon the position angle of immersion and the known angular diameter of Antares, 0.042 second of arc, showed that it took 0.2 second of time for the moon to occult Antares. This agreed tolerably well with my impression while at the telescope that it took from 0.2 to 0.5 second for the star to fade away.

The occultations of October 27, 1950, when the moon passed in front of the Pleiades, were interesting but not particularly dramatic. Since I was out of town, I used my 3-inch traveling telescope, at 45 power, but the moon was so bright that a Herschel solar wedge minus its dark glass was pressed into service to dim the glare.

With these few remarks and those made last month, we leave the subject of occultations as a spectacle. Observers who time them exactly have to go about their work in a more businesslike way.

The moon in its motion gives us the most accurate check on the earth "clock" that we have. A stellar occultation enables us to "read the clock," checking both the motion of the moon and the rotation of the earth on its axis. There are, of course, many factors that complicate the results, such as the variations of the moon's motion and the irregularities of its limb features. This latter problem is being overcome by detailed maps of the edge of the moon traced by an automatic machine at the U. S. Naval Observatory; when the maps are finished, occultation observations should have more value than ever.

As I know little of these matters, I consulted Mrs. Margaret W. Beardsley, R. D. 1, Springfield, Vt., chairman of the occultation committee of the AAVSO, and J. J. Neale, 29 Fairmont Ave., New Haven, Conn., a skilled occultation observer. Mrs. Beardsley kindly sent me a pamphlet, "On Observing Occultations," by herself and Dr. Alice H. Farnsworth, of Mt. Holyoke College, and Mr. Neale sent me his paper, "Observations of Occultations," which he presented at the 1950 general convention of the Astronomical League. From these and their answers to specific questions I have learned the following facts, which will serve as an introduction to this observing program.

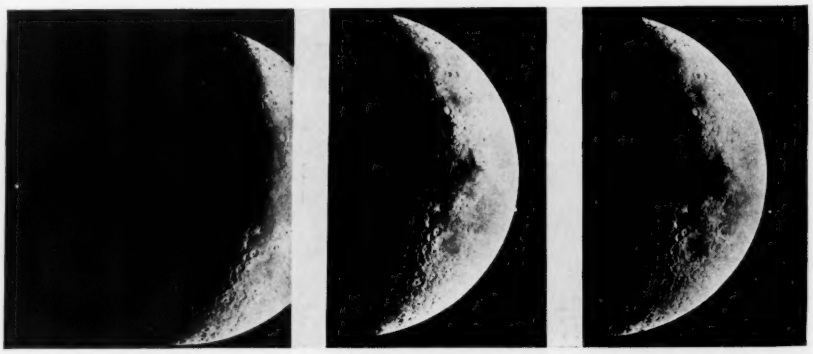
The observations made should be sent to Mrs. Beardsley, who will in turn forward them to the British Nautical Almanac Office for reduction along with similar observations from all parts of the world. Mrs. Beardsley states that more observers would be very acceptable. Some do excellent work their first year, but one who observes with tolerable regularity over a period of several years will naturally increase in value to the program as he becomes more experienced.

Observing Hints. As Mr. Neale points out, a pair of binoculars is probably enough optical aid for the occultation of a 1st-magnitude star, such as Aldebaran. Many occultations of moderately bright stars can be well seen in a 3-inch instrument, but in general a 6-inch telescope is the most practical. A clock drive is not necessary, though it should be a convenience.

Use an eyepiece that will show all the moon at one time with a fairly narrow edge of black all around it. For an eyepiece with an apparent field of view of 45 degrees, this corresponds to about 80 power no matter what size the telescope may be, so choose an eyepiece that will give you about this power with your instrument. The focusing should be done on the star, not the moon.

To avoid glare, it is often advisable to withdraw your eye several inches from the eyepiece, keeping in view only the star and the edge of the moon nearby. Another help is to point the telescope so that it shows only the star and a small portion of the moon.

After you have watched one occultation, it will become apparent to you that it is



An occultation of Aldebaran, with immersion at the dark limb and emersion at the bright limb. The third picture was taken 1 2/3 minutes after emersion. Yerkes Observatory photograph.

easier to time an immersion (disappearance) than an emersion (reappearance). In fact, the few times I have tried to spot the latter, I have found that the star has popped out clear of the moon before I noticed it. It will also be easier to time an immersion at the dark limb of the moon than at the bright limb. This condition obtains between new moon and full moon, at which period the dark limb is on the advancing eastern edge of the moon.

A beginner should start by observing dark-limb immersions, but when you become more proficient the British Nautical Almanac Office will become interested in your work on emersions as well. Before timing an emersion, you should calculate, or estimate, for your station the approximate position angle at which the star will reappear. Do not gaze fixedly at this point, but allow your eye to roam back and forth over the area.

The following table shows the faintest magnitudes that one should attempt to observe during each lunation. While some 1,800 stars of magnitude 6.5 or brighter are occulted somewhere each year, this number shrinks to less than 100 at any given location, and to 40 or less for practical observation by any one observer.

Age of moon	Immersion dark limb	Emersion bright limb
0 to 1 day old	Make no observations	
1 to 2 days old	1.9	—
2 days old to 3 days before full	7.5	3.5
3 to 1 days before full	5.5	3.5
1 day before full to full	3.0	3.0
	Immersion bright limb	**Emersion dark limb**
Full to one day after full	3.0	3.0
1 to 3 days after full	4.5	3.5
3 days past full to 2 before new	4.5	6.5
2 to 1 day before new	1.9	—
1 to 0 days before new	Make no observations	

Timing. The purpose of the entire observation is to determine with the greatest accuracy possible the time at which the star disappears or reappears from behind the moon. The most practical devices for this purpose are a good stop watch and a short-wave radio tuned to the time signals of Station WWV, National Bureau of Standards, Beltsville, Md.

At the instant the occultation occurs, the observer punches the stop watch to start it running. He immediately takes the watch to the radio and stops it at one of the time signals occurring on an exact minute. The stop watch reading is then subtracted from the exact minute at which it was stopped to give the instant of occurrence of the immersion or emersion. Overall accuracy in one's work of closer than one second is essential, and an accuracy of 0.5 second should be one's goal.

I am not able to hear WWV on my regular radio, which also has two short-wave bands, but I am told that this is because I am using the built-in coil antenna. Apparently a roof antenna is needed, and a friend's short-wave radio which was thus equipped received usable though not good signals. WWV broadcasts on 2.5, 5, 10, 15, 20, 25, 30, and 35 megacycles; if you don't hear it on one wave length, try the others. The government time service is described in U. S. Naval Observatory **Circular No. 14,** March, 1950, which states:

"A pulse 0.005 second in duration is transmitted on every second, except the 59th second of each minute. These pulses consist of five cycles of a 1,000-cycle audio note, and are heard as clicks when listening to the broadcast. They are superimposed on an audio frequency. At precisely one minute before the hour and at every multiple of five minutes thereafter the audio frequency is interrupted for an interval of exactly one minute, for the purpose of making announcements. The Universal Time when the audio tone will be resumed is transmitted in International Morse Code, using four digits on the twenty-four hour system, and starting with 0000 at 0^h Universal Time. The first two digits give the hour and the last two give the minutes. Station WWV also makes a voice announcement of the hour and minutes in Eastern Standard Time. The time signal beats continue during the interruptions.

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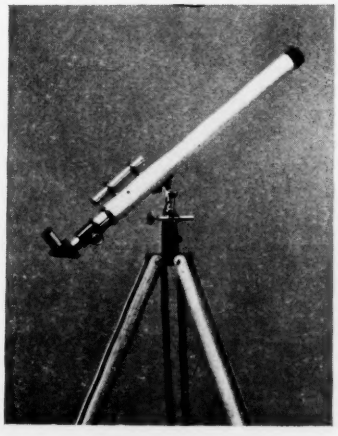

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first four minutes of each hour a modulated frequency of 600 cycles per second is transmitted. This is followed by a transmission of 440 cycles [a on the musical scale] during the fifth to the ninth minute. These frequencies continue to alternate during the remainder of the hour."

If you can't receive WWV, then get your time from an observatory clock whose exact error is known.

Latitude and Longitude. The observer will need to determine his latitude and longitude exactly, as well as his approximate elevation above sea level, submitting this information with his first report. In the United States, consult a U. S. Geological Survey map, which you can probably find at a local library or in a surveyor's office. Try to get the new maps which are to a scale of two inches to the mile.

Your position must be known also for the purpose of predicting the time of an occultation at your own location. This saves your having to wait around until the occultation occurs. Information concerning the brighter stars appears every month here on the Observer's Page, and the **American Ephemeris** and the **British Nautical Almanac** contain additional data for fainter stars (and for other standard stations throughout the world).

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JANUARY METEORS

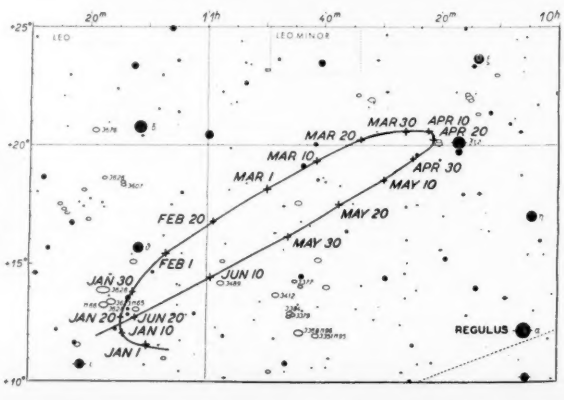
The best annual meteor shower for the first half of the year comes during the first five days of January. The Quadrantids, of medium speed and with predicted rates up to 40 per hour, come to maximum on January 3rd. The first-quarter moon sets about midnight, so observations of the meteors are favored. The radiant is in northern Bootes, at 230°, +52°.

E. O.

VESTA AT OPPOSITION

The brightest of the minor planets, Vesta, may be favorably observed for the next few months with small field glasses or binoculars. Opposition to the sun takes place March 1st, when the asteroid will attain magnitude 6.6. Try plotting Vesta's path from your own observations and compare it with the accompanying chart. If you are a variable star enthusiast, check the changes in brightness during opposition passage.

E. O.



The path of Vesta from January to June, 1952, in Leo. All stars brighter than magnitude 7.5 are shown, the asteroid being no fainter at any time. Chart from Skalnate Pleso "Atlas of the Heavens," co-ordinates for 1950. Plotted by Edward Oravec.

DEEP-SKY WONDERS

THE READER who looks to the index in Admiral Smyth's **Celestial Cycle** for M42, the great Orion nebula, will fail to find it listed. This is not an incredible omission born of some careless printer, but rather a reflection of the prevailing amateur interests of the early 19th century. This most impressive nebula in the entire heavens is listed in Smyth as a mere addition to the entry on the double star Theta Orionis.

Reputedly missed by Galileo, the Orion nebula was discovered by Cysatus of Lucerne in 1618, and Christian Huygens in 1656. Legend has it as the first object viewed by Sir William Herschel with his first successful telescope (after 200 previous failures at speculum making); and, years later, it was the final object to be looked at with the 40-foot reflector when that great glass was laid aside forever. It was the first nebula to be photographed (by Henry Draper) and its spectrum as observed by Huggins was the first major destruction to the Herschelian theory that all nebulae were composed of stars and therefore ultimately resolvable.

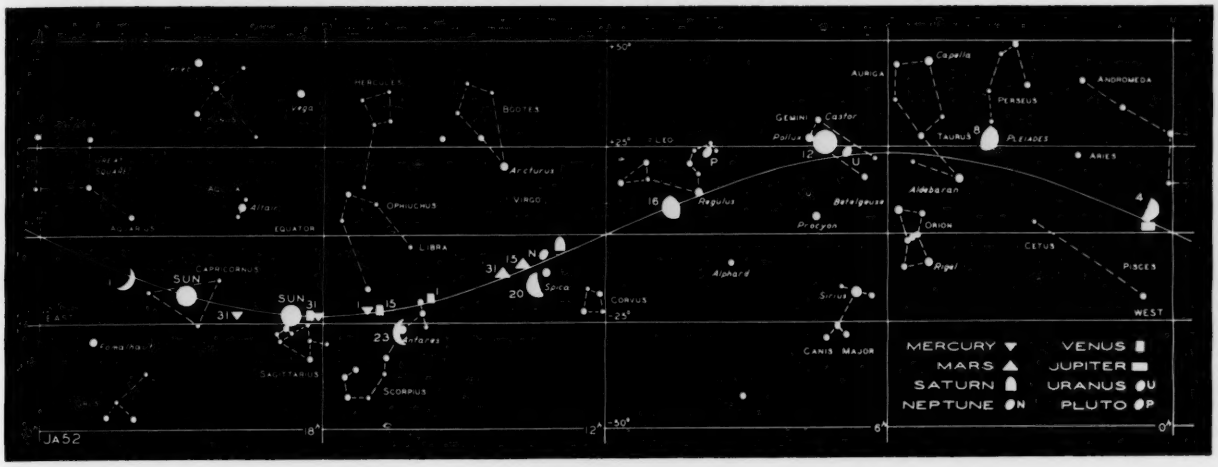
Today, it is the first object the stargazer turns to these crisp winter evenings. The amateur maker of a Schmidt camera feels that the Orion nebula is the only proper test of his workmanship. And the variable star observer includes it on his schedule as he follows the perplexing nebular variable, T Orionis, immersed in the milky light. Whether with opera glasses, or with 16-inch reflectors, no spectacle is better devised to open the year's observing, no object brings more gasps from casual visitors, and no nebula has such continuing power to stimulate the veteran lover of the stars.

WALTER SCOTT HOUSTON

VARIABLE STAR MAXIMA

January 2, S Sculptoris, 6.8, 001032; 7, T Columbae, 7.6, 051533; 8, S Hydrae, 7.9, 084803; 28, R Aurigae, 7.8, 050953; 29, R Virginis, 6.9, 123307. February 5, S Carinae, 5.7, 100661.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will be visible all month in the morning sky as an object of zero magnitude. Greatest elongation is on January 6th, with Mercury 23° 2′ west of the sun in longitude. The planet then rises 1¾ hours before the sun; by the end of the month this time will decrease to under one hour.

Venus rises about one hour before dawn in mid-January, continuing to draw closer to the sun in the sky. Its magnitude is —3.6. Telescopically, the planet's disk is 15″ in diameter, 75 per cent illuminated on the 15th.

Mars, in eastern Virgo, rises about midnight. On the 2nd, it is in conjunction with Neptune, passing 10′ north of that planet at 17:00 UT. Several hours later, Mars has the same right ascension as Spica, but is 4° 10′ north of the star. Western quadrature with the sun occurs on January 21st, when Mars is at +1.0 magnitude.

Jupiter, the only naked-eye planet in the evening sky, is west of the meridian after sunset. Moving eastward in Pisces, Jupiter shines at magnitude —1.9, its disk 38″ in equatorial diameter. The positions of ts satellites are in the chart at the right.

Saturn rises near the east point about midnight, at western quadrature on the 6th. It is in central Virgo, and of the 1st magnitude. The rings are inclined 9°.7 to our line of sight, the north face showing, with a major diameter of 40″ on the 15th.

Uranus, at opposition on January 3rd, is in retrograde motion midway between Zeta and Epsilon Geminorum. It is of the 6th magnitude.

Neptune rises about midnight, at western quadrature on January 12th. The following day it is in conjunction with Spica, 4° 0′ north of the star. An interesting conjunction of Neptune and Mars takes place on January 2nd.

NOTE: All of the planets may be viewed sometime during the night throughout January. Before dawn all will be above the horizon save Jupiter, which sets about 11 p.m.

E. O.

MOON PHASES AND DISTANCE

First quarter	January	4,	4:42
Full moon	January	12,	4:55
Last quarter	January	20,	6:09
New moon	January	26,	22:26
First quarter	February	2,	20:01

	January		Distance	Diameter	
Apogee	12,	6h	252,500 mi.	29′	24″
Perigee	26,	12h	221,900 mi.	33′	28″
	February				
Apogee	8,	9h	252,400 mi.	29′	25″

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

OCCULTATION PREDICTIONS

January 9-10 **136 Tauri** 4.5, 5:50.3 +27-36.2, 13, Im: **A** 6:50.3 —0.9 —1.8 108; **B** 6:44.1 —1.0 —1.6 101; **C** 6:53.9 —0.8 —2.4 124; **D** 6:41.4 —1.1 —2.0 113; **E** 6:38.1 —1.1 —3.3 140; **G** 5:37.1 —1.8 —0.5 108; **I** 5:21.5 —1.8 —0.1 110.

January 16-17 **Upsilon Leonis** 4.5, 11:34.5 —0-33.5, 20, Im: **E** 12:32.9 +0.1 —3.2 183.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, **UT, a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

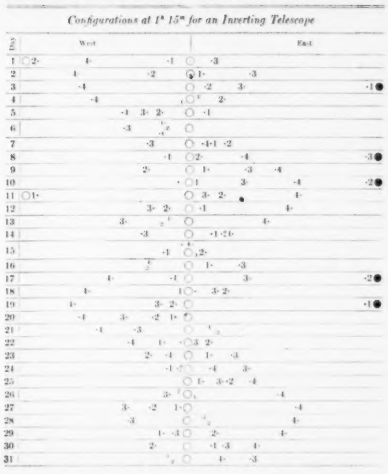
The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +31°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the **American Ephemeris and Nautical Almanac.**



SKY PUBLICATIONS

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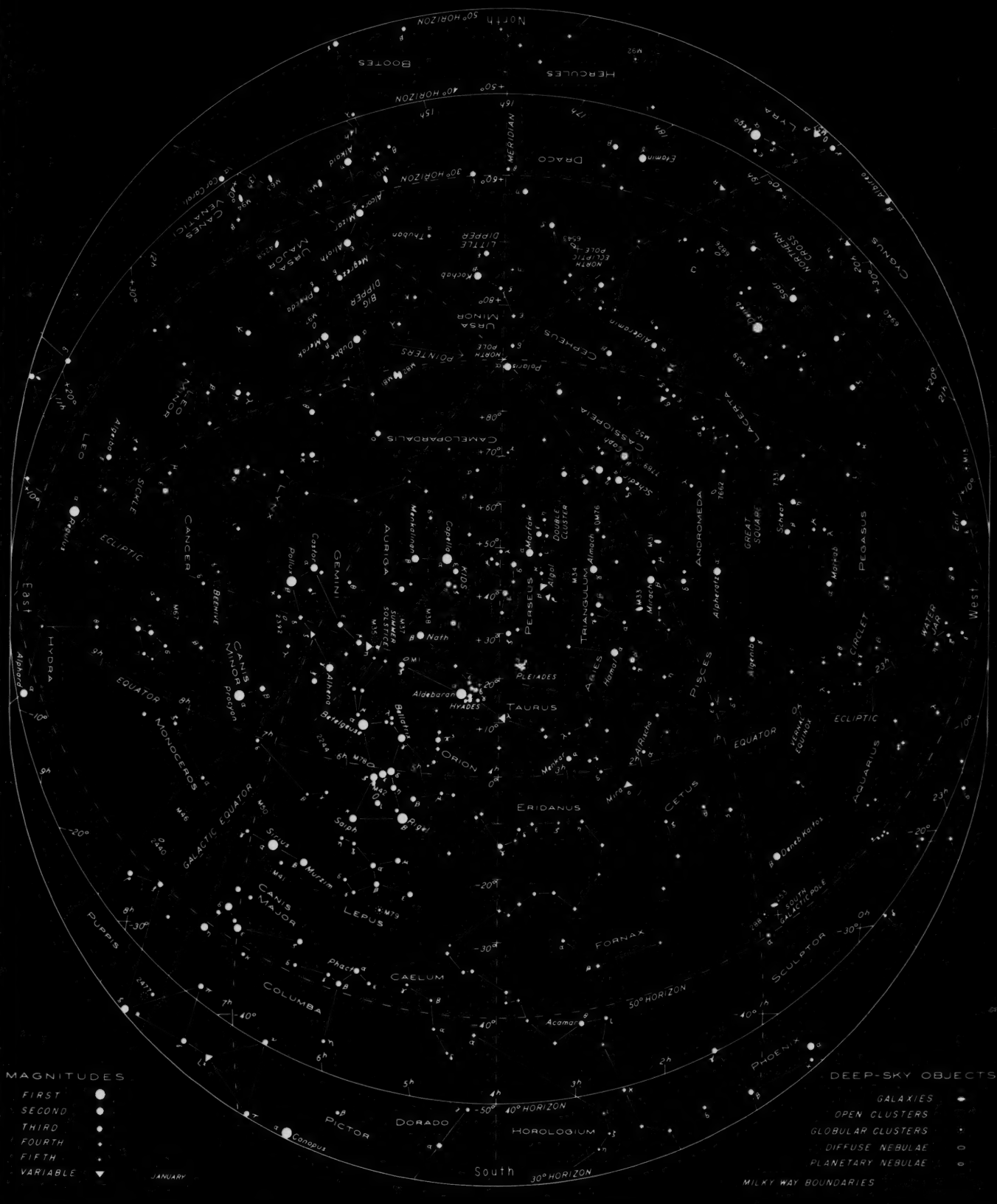
State	City	Organization	Time	Meeting Place	Communicate With
ALABAMA	Gadsden	Ala. A.A.	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176W or 55
ARIZONA	Phoenix	*Phoenix Obs. Ass'n.	8:00, 1st, 3rd Tue.	Phoenix College	Paul E. Griffin, 1708 S. 3rd St.
CALIFORNIA	Kentfield	*Marin Am. Ast.	8:00, 4th Fri.	Marin College	Mrs. I. Osborn, 223 Santa Margarita, San Rafael
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner, 12008 E. Sproul St.
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Miss A. Roemer, 1556 Everett, Alameda
	Palo Alto	*Peninsula A.S.	7:30, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Sacramento	*Sac. Val. A.S.	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, Bayview 3757
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton College, P-11	W. A. Craig, 1043 W. Park
COLORADO	Denver	†*Denver A.S.	8:00, 2nd, 4th Mon.	Chamberlin Obs.	W. E. Johnson, 264 S. Gilpin St. (9)
CONNECTICUT	Middletown	*Centr. Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	Walter Fellows, Middle Haddam
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	Norwalk A.S.	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	Stam. Museum A.A.	8:00, 3rd Fri.	Stamford Museum	R. F. Ives, Post Rd. East, Darien
DIST. COL.	Washington	†Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Janet Perkins, 2141 Eye St. NW (7), RE 7676
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	*J.A.A.C.	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†Key West A.C.	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	South'n Cross A.S.	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
	Miami Springs	*Gulfstream A.A.	Irregular	Orange Bowl	L. G. Pardue, 641 Falcon, 88-5434
GEORGIA	Atlanta	†*Atlanta A.C.	7:30, 2nd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	†*Burnham A.S.	4:00, 2nd Sun.	Adler Planetarium	Wm. Callum, 1435 Winona St.
	Geneva	*Fox Valley A.S.	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th St., St. Charles
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†Indiana A.S.	2:15, 1st Sun.	Riley Library	Clark B. Hicks, 305 Ruckle St.
KANSAS	Topeka	*Topeka A.A.S.	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†*Wichita A.S.	8:00, 1st Wed.	214 East High Sch.	S. S. Whitehead, 2322 E. Douglas, 62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
LOUISIANA	New Orleans	A.S. of N.O.	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†A.S. of Maine	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:15, 1st Thu.	Harvard Obs.	Dr. Dorrit Hoffleit, Harvard Observatory
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	H. Smith, 26 Kingman St., Weymouth, 9-3438-R
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Ann Arbor	†Ann Arbor A.A.A.	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†B. C. Ast. Club	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†*Detroit A.S.	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†*Lansing A.A.	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	†*Pon.-N.W. Det. A.A.	3:00, 3rd Sun.	Cranbrook Inst.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Duluth	†*Darling A.C.	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin Superior, Wis.
	Minneapolis	M'polis A.C.	7:30, 1st, 3rd Wed.	Public Library	Jane Simmer, 2406 Clinton Ave. S.
	St. Paul	*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. H. Wolcott, 1705 Scheffer Ave. (5)
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, Last Sat.	Morrison Obs.	R. C. Maag, 807 W. 7th, Sedalia
	Kansas City	†*A.A. & T.M.s	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd or 4th Sat.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 E. Pacific, Webster Groves 19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Caldwell	West Essex A.A.	8:00, 2nd Mon.	Caldwell Mun. Bldg.	D. C. Smith, 19 Francisco Ave., W. Caldwell
	Jersey City	†Revere Boys Club	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Roselle Park	†A.A.S. of Union Co.	...., 4th Fri.	Boro Hall	Mrs. R. N. Bochau, 236 Normandy Vill., Union
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW MEXICO	Las Cruces	A.S. of L.C.	...., 1st Sat.	Private homes	C. W. Tombaugh, 636 S. Alameda
NEW YORK	Buffalo	†*A.T.M.s & Observers	7:30, 1st, 3rd Wed.	Mus. of Science	Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga
	Gloversville	†*A.C. of Fulton Co.	.....	.....	L. R. Ogden, 60 W. Pine St.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	New York	†Junior A.C.	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., TR 3-1300
	Rochester	†Rochester A.C.	8:00, Alt. Fri.	Rochester Museum	H. O. Woodard, 185 Hayward Ave. (9)
	Schenectady	†*S'tady A.C.	7:30, 2nd Mon.	Nott Terrace H.S.	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	7:30, Alt. Tue.	Sage Lab., R.P.I.	S. J. Lukasik, 31 Belle Ave.
	Utica	†*Utica A.A.S.	7:30, 4th Tue.	Proctor Inst.	John Zimm, 239 Thieme Pl.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†*Greensboro A.C.	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Z. V. Conyers, 210 W. Fisher Ave.
	Raleigh	†Astronomical Soc.	...., 1st, 3rd Thu.	N. C. State Coll.	Richard C. Davis, Sch. of Textiles
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	Robert Berkmeier, 2432 Ohio Ave.
	Cincinnati	*Cin. A.S.	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. A. Townhill, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	8:00, 2nd Fri.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, RR 7, Box 253A (9)
	Lorain-Elyria	*Black River A.S.	7:30, 2nd Tue.	Lorain YMCA	Louis Rick, Box 231, Lorain
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	...., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OKLAHOMA	Tulsa	†Tulsa A.S.	7:30, 1st Sat.	Private homes	Roy N. O'Mara, 1112 N. Braden
OREGON	Portland	†*Portland A.S.	8:00, 1st Mon.	Planetarium	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Mus. of Sci. and Ind.	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 3rd Fri.	Cherry City Fire House	Cliff Raible, Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, RIT 3050
	Philadelphia	†*Rittenhouse A.S.	8:00, 2nd Fri.	Morgan Physics, U. Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	G. Winterhalter, 5-J Terrace, McKees Rocks
RHODE ISLAND	Providence	Skyscrapers, Inc.	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., Jackson 1-5680
S. CAROLINA	Columbia	North'n Cross A.S.	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	C. T. Jones, 1102 James Bldg., 7-1936
	Nashville	*Barnard A.S.	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, U6-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Fri.	Texas Christian U.	L. C. Eastland, 5501 Byers Ave. (7)
	Houston	Houston A.S.	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
	Port Arthur	†*Port Arthur A.C.	...., 2nd Tue.	Private homes	G. van den Berg, Box 266, Groves
UTAH	Salt Lake City	†*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†Springfield T.M.s	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†*Norfolk A.S.	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	Builders Exchange	Miss L. Sievers, 4018 Clinton Ave. (27)
WASHINGTON	Spokane	*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Chet Brown, W. 1117-14th
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	Beloit A.S.	...., 1st, 3rd Thu.	YMCA Bldg.	Kenneth W. Schultz, 959 Johnson St.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis


North
50° HORIZON
40° HORIZON
30° HORIZON
MERIDIAN
BOOTES
HERCULES
LYRA
CYGNUS
DRACO
CEPHEUS
CASSIOPEIA
CAMELOPARDALIS
LACERTA
URSA MAJOR
BIG DIPPER
URSA MINOR
LITTLE DIPPER
NORTH POLE
POINTERS
NORTH ECLIPTIC POLE
NORTHERN CROSS
CANES VENATICI
LEO MINOR
LEO
SICKLE
ECLIPTIC
CANCER
BEEHIVE
GEMINI
AURIGA
PERSEUS
TRIANGULUM
ANDROMEDA
GREAT SQUARE
PEGASUS
CIRCLET
WATER JAR
ARIES
PISCES
PLEIADES
HYADES
TAURUS
ORION
ERIDANUS
CETUS
AQUARIUS
EQUATOR
VERNAL EQUINOX
HYDRA
CANIS MINOR
MONOCEROS
GALACTIC EQUATOR
CANIS MAJOR
LEPUS
PUPPIS
COLUMBA
CAELUM
FORNAX
SCULPTOR
SOUTH GALACTIC POLE
PHOENIX
PICTOR
DORADO
HOROLOGIUM
Canopus
Sirius
Rigel
Betelgeux
Aldebaran
Procyon
Alhena
Castor
Pollux
Capella
Algol
Mirfak
Almach
Alpheratz
Schedir
Caph
Navi
Markab
Scheat
Algenib
Achernar
Fomalhaut
Diphda
Menkar
Mira
Acamar
Phact
Suhail
Alphard
Regulus
Denebola
Vindemiatrix
Spica
Arcturus
Alkaid
Mizar
Alcor
Thuban
Rasalhague
Altair
Deneb
Vega
Albireo
Eltanin
Kochab
Polaris
Dubhe
Merak
Alioth
Megrez
Phecda
Algieba
Alphecca
Antares
Rasalgethi
Kornephoros
Sabik
Ras Alhague
Unukalhai
Zubenelgenubi
Zubeneschamali
Dschubba
Graffias
Nath
Menkalinan
Hamal
Sheratan
Mesarthim
Algorab
Denebola
Kaus Australis
Nunki
Ascella
Rukbat
Arkab
Alnasl
Kaus Borealis
Sadr
Gienah
Minkar
Avior
Miaplacidus
Aspidiske
Suhail
Naos
Canopus
Sirius
Adhara
Wezen
Aludra
Furud
Muliphein
Gomeisa
Procyon
Alhena
Wasat
Mebsuta
Propus
Tejat
Alnath
Saiph
Rigel
Bellatrix
Betelgeux
Mintaka
Alnilam
Alnitak
Meissa
Heka
Hatysa
Murzim